ASSOCIATION OF CLINICAL PARAMETERS - COUGH AND FAST BREATHING WITH PNEUMONIA IN CHILDREN OF AGE GROUP 2 MONTHS TO 15 YEARS

Dissertation

Submitted to

THE TAMILNADU Dr. M.G.R MEDICAL UNIVERSITY

In partial fulfilment of the requirements for

the award of the degree of

M.D. PEDIATRICS

BRANCH VII

MAY 2019

CERTIFICATE - I

This is to certify that this dissertation entitled **"ASSOCIATION OF CLINICAL PARAMETERS-COUGH AND FAST BREATHING WITH PNEUMONIA IN CHILDREN OF AGE GROUP 2 MONTHS TO 15 YEARS"** is a bonafide record of the work done by **Dr. MOHANASELVAN K.V.** under the guidance and supervision of **Dr. Rugmini K.,** in the Department of Paediatrics during the period of his postgraduate study for **M.D. Paediatrics [Branch -VII]** from 2017-2019.

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CERTIFICATE II

This is to certify that this dissertation work titled **"Association of Clinical Parameters-Cough and Fast Breathing with Pneumonia in Children of Age Group 2 Months to 15 Years"** of the candidate **Dr. Mohanaselvan K.V.** with Registration Number 201717702 for the award of **MD** in the branch of **Paediatrics [Branch-VII]**. I personally verified the urkund.com website for the purpose of plagiarism Check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows **12** percentage of plagiarism in the dissertation.

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DECLARATION

In the following pages is presented a consolidated report of the study **"ASSOCIATION OF CLINICAL PARAMETERS-COUGH AND FAST BREATHING WITH PNEUMONIA IN CHILDREN OF AGE GROUP 2 MONTHS TO 15 YEARS"** on cases studied by me at Sree Mookambika Institute of Medical Sciences, Kulasekharam from 2017-2018. This thesis is submitted to the Dr. M.G.R. Medical University, Chennai in partial fulfilment of the rules and regulations for the award of MD Degree examination in Paediatrics.

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ACKNOWLEDGEMENT

With overwhelming thanks, I submit this effort to God Almighty for being the consistent source of support and strength throughout the process of this study.

My deepest gratitude and respect to my beloved Chairman ***Dr. C.K. Velayuthan Nair*** *and Director* ***Dr. Rema V. Nair*** *for providing facilities to accomplish my dissertation work.*

My sincere heartfelt thanks to Professor and HOD ***Dr. K.E. Elizabeth,*** *whom I am highly indebted for her relentless help, proficient ideas and constant encouragement.*

I consider it my distinct privilege and honour to have worked under the guidance and supervision of ***Dr. Rugmini K****, professor of Paediatrics, Sree Mookambika Institute of Medical Sciences, Kulasekharam. I express my feeling of gratitude and sincere appreciation for her guidance, constant support and encouragement in making the study possible. Her constant help, patience and guidance helped me at every stage from conception to completion of this dissertation. I am blessed and privileged to be taught by such an eminent teacher.*

I also thank with due respect and deep gratitude to my respected teacher ***Dr. C. Sulekha,*** *Formerly Professor and Head, Department of Paediatrics, Sree Mookambika Institute of Medical Sciences, Kulasekharam, for their precious timely suggestions and advice that helped me to a great extent.*

I extend my deep sense of gratitude and sincere thanks to ***Dr. Sanjay Masaraddi****, Associate Professor, for his help, unconditioned support, valuable suggestion and encouragement in completing this study*

I humbly thank ***Dr. Nedunchezhiyan,*** *Associate Professor and other teaching and non-teaching staff members for their support and co-operation in completing this work.*

I also thank ***Dr. Balaji S Mahendran*** *MD (SPM), for helping me in statistical analysis.*

I would like to express my heartiest thanks to my Co-Postgraduates- ***Dr. Nargis Rabiya*** *and* ***Dr. Thirumalai Vasan*** *for their help and support in completion of my thesis.*

I am grateful to all the parents of children of the study for their kindly cooperation.

My thanks to Leos Data Makers, Kulasekharam for their assistance in the timely completion of the work.

Lastly, I am forever indebted to my parents and my wife for their support and understanding throughout my study period. Without the love and extra ordinary patience of my dear parents and wife, I would not have been finished my thesis.

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LIST OF ABBREVIATIONS

ALRI	-	Acute Lower Respiratory Tract Infection
ARI	-	Acute Respiratory Infection
ARI	-	Acute Respiratory Infection
C	-	Celsius
CAP	-	Community-acquired pneumonia
CRP	-	C-Reactive Protein
CXR	-	chest X-ray
DC	-	Differential Count
ESR	-	Erythrocyte Sedimentation Rate
F	-	Fahrenheit
HIV	-	Human Immunodeficiency Virus
IDSA	-	Infectious Diseases Society of America
LBW	-	Low Birth Weight
LRTI	-	Lower respiratory tract infections
M	-	Month/months
SpO2	-	Oxygen saturation
TC	-	Total count
WBC	-	White Blood Cells
WHO	-	World Health Organisation
X-ray	-	Radiograph
Y	-	Year

ABSTRACT

ABSTRACT

Objective: To study the association of clinical parameters-cough and fast breathing with radiologically confirmed pneumonia in children of age group 2 months to 15 years.

Methods: Our study was a descriptive study. A total of 100 children in the age group 2 months to 15 years presenting to our institution with cough and fast breathing were included in the study. All the children were examined, relevant history obtained, routine blood investigations done and chest X-ray was taken. Chest radiographs were read by two different paediatricians who were blinded about patient details. X-rays were interpreted according to WHO chest radiograph interpretation document and were classified as either radiologically confirmed pneumonia or no pneumonia. The association of various clinical parameters with radiologically confirmed pneumonia in the study population was analysed statistically.

Results: Out of 100 children, 44 (44%) had radiologically confirmed pneumonia and 66 had no pneumonia. Presence of history of fever (P value= 0.023), refusal of feeds/fluids (P value=<0.001), temperature $\geq 38^0$ C (P value=<0.001), oxygen saturation < 95% (P value=<0.001), nasal flaring (P value=0.004), grunting (P value=<0.001), chest retractions (P value=<0.001), crepitations (P value=<0.001), anemia (P value=<0.001) and malnutrition (P value=<0.001) were significantly associated with radiologically confirmed pneumonia. The presence of history of wheeze and rhonchi on examination were associated with no pneumonia.

Conclusion: Presence of cough and fast breathing is equated as clinical evidence of pneumonia among under-five children as per WHO guidelines. But clinicians often use these parameters above the age of 5 years as well. This study emphasizes that cough and fast breathing can be used as clinical parameters to identify pneumonia even in children more than 5 years of age. Presence of temperature $\geq 38^0$ C, presence of malnutrition and crepitations were independent predictors of radiologically confirmed pneumonia. History of wheeze and presence of rhonchi were significantly associated with no pneumonia. Antibiotic abuse and chest X-ray to confirm pneumonia can be avoided in children with hyper reactive airway disease.

Key words: Radiologically confirmed Pneumonia, Pneumonia, Chest Radiograph, Clinical Parameters

INTRODUCTION

INTRODUCTION

Respiratory tract infections are perhaps the most common human ailment. While they are a source of discomfort, disability and loss of time for most adults, they are substantial causes of morbidity and mortality in young children.[1]

Acute respiratory tract infections are the leading cause of mortality and morbidity in both the developed and developing countries. World Health Organisation (WHO) estimated the burden of respiratory tract infections in 2010 and found that four and half million deaths are due to respiratory tract infections among children every year. In India, 1.2 million deaths are due to respiratory tract infections among 5.9 million deaths globally.[2]

The respiratory tract infections are broadly divided into upper and lower respiratory tract infections. Lower respiratory tract infections (LRTI) are most common cause of death than upper respiratory tract infections. These LRTI are affected by socio demographic and socio-cultural factors which are modifiable by simple interventional measures.[3] Risk factors which were modifiable were lack of breast feeding, overcrowding, under nutrition, delayed weaning and pre-lacteal feeds. The etiological agents of LRTI are viral, bacterial or both combined together.[4] Pneumonia and bronchiolitis are most common types of LRTI in children. Pneumonia accounts for the most of the deaths in children less than 5 years.[5]

Pneumonia is one of the oldest diseases, as old as antiquity known to human kind. It has always remained a subject of challenge to medical science, despite the extensive research done. Pneumonia is the number one cause of under-5 childhood

mortality in all the countries, particularly in developing countries. Over the years the mortality remained the same and it is also been called as "forgotten killer" or "silent killer".[6] Pneumonia, defined as inflammation of the lung parenchyma, is the leading cause of death globally among children younger than age 5 year, accounting for an estimated 1.2 million (18% total) deaths annually.[7] Pneumonia kills more number of children than any other diseases, more than Acquired Immuno Deficiency Syndrome (AIDS), malaria and measles combined. Global burden of disease estimates 2010, stated that the ALRI is the leading cause of death among children aged under 5 years in developing countries.[8]

The implementation of safe, effective and affordable interventions has reduced pneumonia from 4 million in 1981 to just over one million in 2013, pneumonia still accounts for nearly one fifth of childhood deaths worldwide.[9]

Approximately 150 million episodes of pneumonia in childhood are reported every year worldwide, out of which 95% are from developing countries. The 15 countries accounts nearly 75% and 6 countries including India accounts for 50%. India alone bears 25% disease burden.[6]

In India, the disease burden is huge. The 45 million episodes are estimated annually with 6.6 million hospitalizations, which contribute to 24% national disease burden and 0.37 million deaths annually.[6]

The WHO defines pneumonia as an acute disease episode with cough combined with fast breathing with age specific cut-values for increased respiratory rate.[10] The accurate diagnosis of pneumonia in children remains an important and yet a difficult clinical problem. As the WHO proposal for developing countries, the

clinical suspicion and radiological confirmation of infiltrates, together with different parameters of the history and examination, leads to the diagnosis of Community-acquired pneumonia (CAP).[11]

Community-acquired pneumonia is a very common and serious illness in pediatric patients.[12] Emergency department physicians use a number of criteria to diagnose pneumonia, including clinical and epidemiologic data, findings on chest radiography, and laboratory tests.[13,14] Traditionally, features including cough, fever, wheezing, difficulty breathing, chest pain, and abdominal pain have been significant indicators of pneumonia, but there is disagreement as to their relative contribution to the diagnosis.[13] The reasons for this disparity can be due to the lack of a gold standard for the diagnosis of pneumonia, difficulties in identifying the subtle signs of pneumonia, and variability in the interpretation of chest radiographs.[15]

The chest X-ray remains the diagnostic test of choice in tertiary care centers. A chest radiograph has historically been a major contributor to the diagnosis of pneumonia in children. However, recent research has called into question the necessity of a chest radiograph due to the variability of interpretation and its inability to distinguish between the various microbiological causes.[13, 16-20]

Chest radiographs in patients suspected of having pneumonia are sometimes read as normal, and this can lead physicians to treat pneumonia regardless of radiologic findings.[19] One study showed that 21% of patients clinically diagnosed with community-acquired pneumonia had negative chest radiographs at presentation.[17] The Infectious Diseases Society of America (IDSA) guidelines for management of CAP in infants and children older than three months of age state that routine chest radiographs are not necessary for the confirmation of suspected CAP in

patients well enough to be treated in the outpatient setting.[16] Moreover, chest radiographs are not without risk; though exposure to radiation from a chest radiograph is minimal, future cancer risk increases with the decreasing age of the child and the number of chest radiographs and other radiation exposures.[20]

The accurate diagnosis of pneumonia in children remains an important but yet a difficult clinical problem. The Chest X-ray remains the diagnostic test of choice in tertiary care centers. Given that the decision to pursue a diagnostic chest x-ray in the context of suspected pneumonia is largely influenced by the clinical predictors of pediatric pneumonia, it is important to determine these adequately.

Here, we designed the present study with an aim to determine the clinical parameters associated with radiologically confirmed pneumonia and to determine the need for CXR among children aged 2 months to 15 years presenting with cough and fast breathing.

AIMS & OBJECTIVES

AIMS AND OBJECTIVES

Primary objective

- To study the association of clinical parameters-cough and fast breathing with radiologically confirmed pneumonia in children of age group 2 months to 15 years.

Secondary objective

- To study the association of other clinical and laboratory parameters with radiologically confirmed pneumonia in children of age group 2 months to 15 years.

SCIENTIFIC JUSTIFICATION & HYPOTHESIS

STUDY JUSTIFICATION AND HYPOTHESIS

Pneumonia is a very important cause of morbidity and mortality around the world. Pneumonia is the number one cause of under-5 mortality across the globe particularly in developing countries. In India the disease burden is huge, which contribute to 24% national disease burden. A number of studies were done before to estimate the clinical predictors of pneumonia in less than 5 years old children. There are only limited studies on estimating the clinical predictors of pneumonia in less than 15 years old children. Presence of cough and fast breathing is equated to pneumonia in under 5 children as per the guidelines. Whether the same can be applied to older age group, and by finding the association of the parameters with radiographic pneumonia, and if they are significant the number of chest radiograph being taken to the older children to diagnose pneumonia can be reduced and the usage of antibiotics can be avoided in children with no pneumonia.

To diagnose pneumonia based on clinical symptoms and signs without exposing the child to radiography and to diagnose pneumonia in a resource limited setting where radiography may not be easily accessible.

Null Hypothesis: Cough and Fast breathing is not associated with pneumonia.

Alternate Hypothesis: Cough and Fast breathing is always associated with pneumonia.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Problem statement

Acute Respiratory Infections is responsible for 3.9 million deaths every year worldwide. Around 90% of ARI deaths are due to pneumonia, which is bacterial in origin.[1]

Globally the incidence of pneumonia in children < 5 years in developing countries is 0.28 episodes per child – year (150 million/year), compared to 0.05 episodes per year in developed countries.[21]

In India, in 2013, about 31.7 million cases of ARI were reported. During 2013 about 3,278 children died of ARI and 2597 died due to pneumonia. Pneumonia was responsible for about 18% of all under five deaths in India.[22]

The WHO estimates there are 156 million cases of pneumonia each year in children younger than five years, with as many as 20 million cases severe enough to require hospital admission. In the developed world, the annual incidence of pneumonia is estimated to be 33 per 10,000 in children younger than five years and 14.5 per 10,000 in children 0 to 16 years.[23] Approximately one-half of children younger than five years of age with CAP require hospitalization.

More than half of the world's annual new pneumonia case are concentrated in just five countries where 44% of the world's children under five years of age live: India, China, Pakistan, Bangladesh and Nigeria.[24]

According to WHO, pneumonia is the single largest infectious cause of death in children worldwide. Pneumonia killed an estimated 920136 children under the age of five in 2015, accounting for 16% of all deaths of children under five years old.

The mortality rate in developed countries is low (<1 per 1000 per year). In developing countries, respiratory tract infections are not only more prevalent but more severe, accounting for more than 2 million deaths annually; pneumonia is the foremost cause of mortality in children under 5 years of age.[25]

In India, during the year 2011, Pneumonia cases were about 7.15 lakh, with the incidence rate of about 59 cases per lakh population. Pneumonia was responsible for about 18 percent of all under 5 deaths in India. [Govt. of India 2011, National Health Profile 2011, DGHS, Ministry of Health and Family Welfare, New Delhi]

Hospital record from states with high infant mortality rate show that, 13% of inpatient deaths in pediatric wards are due to ALRTI. The proportions of death due to ALRTI in the community is much higher as many children die at home.[1]

Leventhal et al[26] **in 1982** in his prospective study to establish a set of clinical signs and symptoms that could serve as a guide to when a chest X ray should be obtained in children suspected of having pneumonia found out that tachypnea had the highest predictive accuracy. The presence of any pulmonary finding was also useful predictor of positive chest X-ray.

Zukin DD et al[27] **1986** correlated pulmonary signs and symptoms with chest radiographs in the paediatric age group. They found that the sign with highest positive and negative predictive value for the presence of any radiographic

abnormalities was tachypnea. Absence of fever suggests absence of pneumonia, while chest examination findings other than wheezing, cough, prolonged expiration or rhonchi significantly increased the likelihood of pneumonia. Thus they concluded that physical examination findings could help the clinical determine the need for chest radiography in paediatric emergency patient.

Melbye et al[28] **in1992** did a study on laboratory tests for pneumonia in general practice at the Hospital of Hammerfest, Norway. They found that a highly significant contribution of adding ESR and CRP to physical examination and history, particularly when illness had lasted for one week or more.

Lozano JM et al[29] **in** 1994 studied the clinical predictors of acute radiological pneumonia and hypoxemia at high altitude at the John Hopkins University, USA. They found that crepitations and decreased or increased breath sounds are associated with pneumonia. Hypoxemia is the best predictor when auscultatory findings are excluded. The presence of hypoxemia as detected by non-invasive method such as pulse oximetry was useful for detecting pneumonia and aids in the decision of ordering chest radiograph.

Falade et al[30] during the period 1990 to 1992 did a study at the department of medical research council at Fajara, Gambia to evaluate the power of widely used clinical signs as a predictor of pneumonia in children presenting for the first time with respiratory symptoms and malnutrition. They found that a history of cough, fast breathing or difficult breathing was associated significantly with pneumonia.

Gupta D et al[31] **1996** in their hospital based prospective study have found that, fast breathing as most useful sign predicting pneumonia in all age groups. They

also found that, Crepitations on auscultation were found to have good correlation with presence of pneumonia. They also found that, crepitations on auscultation were found to have good correlation with presence of radiological pneumonia.

Jadavji T et al[32] **in 1997** found that absence of pulmonary cluster i.e., respiratory distress, tachypnea, rales and decreased breath sounds excluded pneumonia accurately.

Korppi M et al[33] **in 1997** evaluated the applicability of C-reactive protein, ESR, WBC and ANC in the screening of pneumococcal pneumonia in children. They found that CRP is recommended as the first line method of screening and the value of 60 mg/L as the cutoff point.

Cherian et al[34] **in 1998** found that respiratory rate cannot be used as criterion for the diagnosis of pneumonia in children above 35 months of age.

Fanelli JM et al[35] in 2000 studied 80 children who were younger than 16 years, they concluded that the presence of any 4 of temperature ≥38°C, oxygen saturation <95%, positive human immunodeficiency virus status, or cough productive of colored sputum was 93% sensitive for identifying radiographic pneumonia.

Kumar N et al[36] **2002** clinically evaluated acute respiratory distress and chest wheezing in infants. They found that presence of fever >100^0F, neutrophilia and opacities on chest X –ray find to the diagnosis of bronchopneumonia in infants with respiratory distress and chest wheezing. They also found absence of fever with normal leukocyte count or lymphocytosis point towards bronchiolitis in infants with respiratory distress at chest wheezing.

Lynch et al[37] **2004** in his prospective study with patients having positive chest X ray were found more likely to have history of fever, crackles, decreased breath sounds, grunting or retractions than patients with normal chest X ray.

Al-Najjar SA et al[38] **in 2004** did a prospective clinical study at Raparin Hospital in Erbil city, Iraq to determine the relationship between clinical and radiologic findings of pediatric patients. They found that fever, tachypnea and chest retractions were found to be highly suggestive of pneumonia.

Wilkins et al[19] **in 2005** found that the major difficulty in diagnosing pneumonia, particularly in first-level health care stings is an absence of easily feasible and definitive gold-standard diagnostic test.

Mahabee-Gittens et al[39] **in 2005 stated** that the chest X-ray evaluation is the fundamental tool to distinguish children with and without pneumonia.

Ramakrishnan et al[40] did a prospective study at Amrita Institute of Medical Sciences and Research Centre Kochi from 2003 to 2004 to evaluate the role of hemoglobin level as a risk factor for lower respiratory tract infections in children. They found that maximum incidence of lower respiratory tract infections was seen in age group below 6 years. This shows that the incidence of LRTI decreases with age.

Murphy et al[41] **in 2007** did a retrospective cross sectional study in a large urban paediatric hospital to identify the predictor of occult pneumonia in paediatric patients of age 10 years or less. They found out that rate of pneumonia to be 5.3% among febrile children without any lower respiratory tract findings, signs of pulmonary distress, tachypnea or hypoxia. There is also limited utility in obtaining a

CXR in febrile children without cough. The likelihood of pneumonia increased with the longer duration of cough or fever or in presence of leukocytosis.

Graham at al[42] **in 2008 found that t**he WHO criteria to diagnose pneumonia in children with cough or difficulty in breathing with tachypnea are sensitive to identify pneumonia cases among children with upper respiratory tract infection. The criteria are not sensitive to distinguish pneumonia from other lower respiratory tract infections.

Mathews et al[43] **in 2009** found out that children for whom radiographs were obtained for the indication of first episode of wheezing were less likely to have pneumonia than were those for whom chest radiographs were obtained for other condition.

Shah et al[44] **in 2010 found that** the standardized management for children with respiratory complaints recommended by WHO has resulted in decreased childhood mortality in developing countries, the recognition that the proposed diagnostic criteria by WHO, that is cough or difficulty in breathing plus tachypnea, are not always sensitive indicator for pneumonia.

Cardoso et al[45] **in 2011** found that the addition of fever to cough and tachypnea on admission greatly enhances the ability to identify pneumonia cases among children with different lower respiratory tract diseases.

Key NK et al[46] **in 2011** found out that it is possible to estimate that presence of fever enhances 2.5 times the chance of children hospitalized with lower respiratory tract disease to have radiographically diagnosed pneumonia. Therefore, the presence of fever on physical examination enhanced the probability of

pneumonia among children under 5 years-old with lower respiratory tract disease and may be useful to distinguish children with pneumonia from those with other lower respiratory tract diseases. They also found that tachypnea was equally frequent among children with or without radiologically confirmed pneumonia.

Neuman et al[15] in 2011, it is important to identify history and physical examination features associated with diagnosis of CAP in children. Results showed that any abnormal breath sounds, rales, cough and duration of fever are significant independent predictors of pneumonia in children with age more than 2 years. They also found that by using history and clinical examination children can be stratified for the risk of radiographic pneumonia. Rate of radiographic pneumonia is high among children who have focal lung findings and hypoxia and low among children who do not have fever or focal findings on auscultation and hypoxia. Patients at low risk should be followed up and need not be subjected for x-ray.

Hussain et al[47] **in 2011** did a prospective study at G.B Pant Hospital, Srinagar and found that the anemic children were 4.6 times more susceptible to lower respiratory tract infections.

Fontoura et al[48] **in 2012 stated that** Persistence of fever or tachypnea up to the second day of amoxicillin treatment is predictive of radiographically diagnosed pneumonia among children with non-severe lower respiratory tract infections.

Salih et al[49] **in 2012** did a prospective hospital based study in Sudan to find the radiological findings in severe pneumonia in children less than five years. They found that chest X-ray is an important tool in diagnosing severe pneumonia. It also helps in deciding severity of the disease. It is also highly recommended for diagnosis

of pneumonia particularly in low income countries where other tools of investigations are very meager. They also found that, diarrheal disease and gastroenteritis and severe malnutrition had strong association with the severity of the disease in this research, which in concordance with other studies done in Middle-east.

Koster et al[50] did a cross sectional study in under 18 children presenting to Antonius hospital Netherland between 2007 and 2012, to find the diagnostic value of CRP level for pneumonia. They found that CRP level has independent diagnostic value for pneumonia in children presenting at emergency department with suspected pneumonia and also found that low levels do not exclude pneumonia in this setting.

Silayach J et al[51] **in 2014** studied the clinicoradiological correlation of children with clinical features of pneumonia in emergency settings. They found that the presence of nasal flaring, grunting, crepitations and decreased breath sounds were associated with radiographic pneumonia. On further analysis, they found that decreased breath sounds was an independent predictors of CXR positive pneumonia.

Mohamed RM et al[52] **in 2014** did a case-control study on association of anemia with pneumonia at Benha University and found that anemia was found to be a risk factor for pneumonia with an OR of 4.03, CI of 1.71-9.49, and P value of 0.001. This means that anemic kids were about four times more susceptible to develop pneumonia compared with non-anemic children.

Nevin et al[53] did a retrospective chart review of patients from birth to 18 years who presented with symptoms suspicious of pneumonia in an urban paediatric emergency department (PED) in 2010 to 2011. They found that the clinical

predictors of pneumonia for children 2 years or older included cough, fever more than 2 days and decreased breath sounds.

Simbalista et al[54] did a retrospective cohort study in more than 2 months old children hospitalized with CAP diagnosed on clinical grounds, treated with aqueous penicillin G and with CXR taken on admission at Salvador, Brazil from 2002 to 2005. They found that patients with radiologically confirmed pneumonia were more feverish on admission and during the first two days of treatment. They also had lower frequency and fever and younger age in the group without radiologically confirmed pneumonia may guide the clinical suspicion to other disease like bronchiolitis.

Goel I et al[55] **in 2016** did an observational and analytic study to find the usefulness of examination findings in predicting chest radiographic abnormalities among children with Lower Respiratory Infections (LRI) at Maharashtra, India. They found that tachypnea, pallor, retractions, grunting, nasal flaring, decreased breath sounds and crepitations were the main indicators of ALRI confirmed by X-ray. Inspection and auscultation were the two more important pillars of respiratory system examination in children, where we could predict abnormal X-ray findings.

Avhad et al[56] did a study in 2016 at the Pediatric outpatient department and Intensive care unit of a tertiary care unit in Mumbai to determine whether anemia is a risk factor for lower respiratory tract infections in children. They found that anemia was found significantly in children with lower respiratory tract infections and these children are 3.59 times more susceptible to lower respiratory tract infections.

Mungala et al[57] did a hospital based prospective cross-sectional study in 2017 at Narayana Medical College, Nellore. They found that cough and breathlessness were the major symptoms associated with lower respiratory tract infections. They also found that bronchopneumonia was the most common clinical entity associated lower respiratory tract infection.

Shampa et al[58] did a cross sectional study at Dhaka medical college from 2010 to 2011 to evaluate the nutritional status of children suffering from pneumonia and bronchiolitis in less than 2 year old children. They found that children with pneumonia often had severe and microcephaly. There was severe wasting and severe stunting in children with pneumonia compared to those with bronchiolitis.

Fancourt et al[59] did a PERCH study in 7 countries to describe the X-ray findings of clinically diagnosed pneumonia cases and determine if there were any differences in findings by geography, epidemiological setting, particular clinical signs or pneumonia risk factors. They found that more specific pneumonia findings are less associated with pneumonia in younger children because physiologic compliance of the lower chest makes this finding common in a variety of setting. They also found that danger signs are not useful criteria for diagnosing pneumonia in more than 6 months old children.

ANATOMY OF RESPIRATORY TRACT[60]

The respiratory tract is divided into upper respiratory tract and lower respiratory tract.

The part above the cricoid cartilage is the upper respiratory tract. It includes nose, nasopharynx, larynx, paranasal sinuses and the Eustachian tube. It has many

important functions such as conduction, swallowing, air conditioning, speech and smell.

The Lower Respiratory Tract

The part below the cricoid cartilage is the lower respiratory tract. It begins at the lower border of the cricoid cartilage. The trachea begins from larynx and divides at the level of lower border of fourth thoracic vertebra into two primary or major bronchi, one for each lungs. Each main bronchus enters the lung through the hilum, and divides into secondary or lobar brhonchi, 3 on the right and 2 on the left, one for each lobes of the lung. Each lower bronchus divides into tertiary or segmental bronchi. The segmental brhonchi divide repeatedly to form small bronchi called the terminal bronchioles.

The terminal respiratory unit or gas exchanging unit consists of structures distal to the terminal bronchiole, the respiratory bronchiole, alveolar ducts and the alveolus. This unit, which is also known as the acinus is considered the basic functional unit of lung.

Bronchopulmonary segments:

Definition:

These are well defined sectors of the lung, each one of which is aerated by a segmental bronchus.

There are ten segments on the right and ten segments on the left.

Table 1: Bronchopulmonary segments

Right lung		Left lung	
Lobes	**Segment**	**Lobes**	**Segment**
Upper	Apical Anterior Posterior	Upper	Apical Anterior Posterior
Middle	Superior Inferior	Lingular	Superior Inferior
Lower	Superior Anterior basal Posterior basal Medial basal Lateral basal	Lower	Superior Anterior basal Posterior basal Medial basal Lateral basal

Defense mechanisms of lung:

Multiple and effective defense mechanisms are important in lungs because the respiratory system is constantly exposed to a changing and polluting environment containing allergens, irritants and pathogens. The defense mechanism is composed of 3 limbs

1. Cough reflex
2. The respiratory muscles
3. The central nervous system control centers

The cough reflex relies on the integrity of the airways. The mechanical defense of the respiratory system that protects the lungs include the filtering of the particles, the humidification and warming of the inspired air and absorption of noxious fumes and gases by the vascular upper airway.

Defense against microbial agents:

In addition to the phagocytosis and mucociliary clearance, cellular killing of the organism and immune responses assist in protecting from bacteria and viruses. Alveolar and interstitial macrophages derived from monocytes are an essential component of defense system of lung.

Definitions:[61]

1) **Pneumonia:** is an inflammatory process involving the lung parenchyma.
2) **Bronchopneumonia:** is a spreading inflammation of the terminal bronchioles and the related alveoli.
3) **Lobar pneumonia (consolidation):** is a pathological state of lung where the alveolar air is replaced by exudates and transudates.
4) **Pneumonitis:** is a localized inflammation of the lung parenchyma due to the non-infectious causes.
5) **Post measles bronchopneumonia:** is a mixed pneumonia involving the alveoli, supportive tissue and bronchioles usually manifest with or after the onset of measles. Radiologically it is seen as peribronchial thickening, usually bilateral and often extensive.
6) **Interstitial pneumonia:** is characterized pathologically by massive proliferation and desquamation of alveolar cells and thickening of alveolar walls. Chest radiograph may reveal a diffuse, hazy, ground glass appearance usually at lung bases with poorly defined hilar densities.
7) **Persistent pneumonia:** is defined as persistence of pneumonic infiltration in the chest radiograph for more than four weeks after effective antibiotic therapy.

8) **Recurrent pneumonia:** is defined as 2 or more episodes of pneumonia in a single year or 3 or more episodes ever, with radiographic clearing between occurrences.

9) **Pleural effusion:** is collection of fluid within pleura, which commonly accompanies inflammatory process in lungs.

10) **Empyema:** is presence of pus in the pleural cavity.

ETIOLOGY [7]

Bacterial

- Streptococcus pneumoniae
- Group A streptococci
- Haemophilus influenza
- Staphylococcus aureus
- Mycoplasma pneumoniae
- Chlamydia trachomatis
- Mixed anaerobes

Viral

- Respiratory syncytial virus
- Parainfluenza types 1-3
- Influenzas A, B
- Adenovirus
- Measles

Fungal

- Histoplasma capsulatum
- Blastomyces dermatitidis
- Coccidioides immitis
- Cryptococcus neoformans
- Aspergillus species

Rickettsial

- Rickettsia rickettsiae

Mycobacterial

- Mycobacterium tuberculosis

Parasitic

- Various parasites - Ascaris, Strongyloides species

Others

- Aspiration
- Hydrocarbons
- Chemicals
- Hypersensitivity pneumonitis
- The etiological factors of pneumonia can be identified in only 65-86 % patients combining multiple diagnostic tools including culture, serology and PCR.[23]

In malaria endemic regions of Africa, a challenging etiological factor is multidrug resistant non-typhoidal salmonella, and in countries where tuberculosis is endemic, it is increasingly being recognized as a cause of acute pneumonia.[62]

Pathogenesis[63]

The lung is protected from bacterial infection by the following mechanisms:

1) Filtration of particles in the nostrils
2) Prevention of aspiration by epiglottal reflex
3) Expulsion of infectious material by cough reflex
4) Expulsion of organism by mucous secreting cells
5) Killing of bacteria by macrophages
6) Neutralization of bacteria by local or specific immunity
7) Transport of particles by lung lymphatic drainage

Alteration in the above barriers results in pneumonia.

Immunologic defense mechanisms of the lungs that limit the invasion by pathogenic organisms includes, macrophages, secretory IgA and other immunoglobulins present.

When the bacterial infection is established, the pathological process varies according to the invading organism.

S. pneumonia produces local edema that aids in proliferation of organisms and spread to adjacent portions of the lung often resulting in characteristic focal lobular involvement.

Group-A streptococcus results in more diffuse infection with interstitial pneumonia. The pathology includes the formation of large amount of the exudates, edema and local hemorrhage with extension into the pleura.

S. aureus manifests by bronchopneumonia which is often unilateral and characterized by extensive areas of cavities in the lungs, resulting in pneumatoceles, empyema and bronchopulmonary fistulas some times.

M. pneumonia results in cellular destruction causing airway obstruction by cellular debris, mucous and inflammatory cells with spread of infection occurring along the bronchial tree.

Viral pneumonia usually results from spread of the infection along the airway resulting in airway obstruction from swelling, cellular debris and secretions. Interstitial edema, atelectasis and ventilation perfusion mismatch accompany airway obstruction. Viral infection can predispose to secondary bacterial infection by disturbing the defense mechanism, altering and modifying the bacterial flora.

CLINICAL MANIFESTATIONS [7, 64, 65]

Pneumonia is frequently preceded by symptoms of an upper respiratory tract infection, typically rhinitis and cough. Tachypnea is the most common and consistent clinical manifestation of pneumonia. Increased work of breathing with intercostal, subcostal and suprasternal retractions, nasal flaring, and use of accessory muscles is common. Severe infections are accompanied by cyanosis and lethargy. Auscultation of the chest reveals crackles and wheezing.

Bacterial pneumonia in adults and older children begins suddenly with high fever, cough, and chest pain. Other symptoms includes drowsiness with intermittent periods of restlessness, rapid respirations, anxiety and occasionally, delirium. In many children, splinting on the affected side to minimize pleuritic pain and improve ventilation is noted.

Physical findings depend on the stage of pneumonia. Early in the illness, diminished breath sounds, scattered crackles and rhonchi are commonly heard over the affected lung field. With the development of increasing consolidation or complications of pneumonia such as pleural effusion or empyema, dullness on percussion is noted and breath sounds may be diminished. A lag in respiratory excursion often noted on the affected side. Abdominal pain is common in lower-lobe pneumonia. The liver may be enlarged because of downward displacement of the diaphragm secondary to hyperinflation of the lungs.

In infants, there may be prodrome of upper respiratory tract leading to the abrupt onset of fever, restlessness, apprehension, and respiratory distress. These infants appear ill, with respiratory distress manifested as grunting, nasal flaring, retractions of the supraclavicular, intercostal, and subcostal areas, tachypnea, tachycardia, air hunger and cyanosis. In infants, physical examination may be misleading, particularly in young infants, with meager findings disproportionate to the degree of tachypnea.

Some with bacterial pneumonia may have associated gastrointestinal disturbances characterized by vomiting, anorexia, diarrhea, and abdominal distention secondary to a paralytic ileus. Rapid progression of symptoms is characteristic in the most severe cases of bacterial pneumonia.

Table 2: Typical features of bacterial, viral and mycoplasma pneumonia in children

Features	Bacterial	Viral	Mycoplasma
Age	Any	Any	5-15 Y
Onset	Abrupt	Variable	Insidious
Fever	High	Variable	Low grade
Tachypnea	Common	Common	Uncommon
Other symptoms	Coryza Abdominal pain	Coryza	Pharyngitis Myringitis
Examination findings	Evidence of consolidation	Variable	Crackle Wheeze
Pleural effusion	Common	Rare	-

Table 3: Typical vs Atypical pneumonia

Features	Typical	Atypical
Onset	Sudden	Gradual
Fever	Present	Present/absent
Cough	Productive	Dry
Symptoms	Pulmonary	Systemic
Chest X ray	Localized	Diffuse
Organism	S. pneumonia S. aureus H. influenza	Mycoplasma Legionella Chlamydia

EPIDEMIOLOGY[7, 66-68]

Epidemiology is emerging as a promising tool for interpreting and understanding the disease in all dimensions and identifying the levels of intervention for their control or eradication. An epidemiological approach to ARI in children can improve the understanding of disease and help to prepare ground for effective control. The principal areas of epidemiology are natural historical strategy and epidemiological enquiry.

The etiological agents that are responsible for pneumonia in developing countries differ greatly from the developed countries. In the developing countries pneumonia is generally caused by bacteria, whereas in the developed countries pneumonia is mostly viral in origin.

The incidence of pneumonia is more than 10-fold higher (0.29 episodes vs 0.03 episodes), and the number of childhood-related deaths from pneumonia ≈2,000 fold higher, in developing than in developed countries. Fifteen countries account for more than three-fourths of all pediatric deaths from pneumonia.

Table 4: Age specific causes of pneumonia[7]

Neonates	Group B streptococcus Escherichia coli Streptococcus pneumoniae Haemophilus influenzae
3 weeks - 3 months	Respiratory syncytial virus other viruses- rhinoviruses, parainfluenza viruses, influenza viruses, adenovirus S. pneumoniae H. influenzae Chlamydia trachomatis
4 months - 5 years	Respiratory syncytial virus Other viruses- rhinoviruses, parainfluenza viruses, Influenza viruses, adenovirus S. pneumoniae H. influenzae Mycoplasma pneumoniae Group A streptococcus
5 years and older	M. pneumoniae S. pneumoniae H. influenzae Influenza viruses Adenovirus Legionella pneumophila

Risk factors for pneumonia[69]

Risk factors affecting incidence of childhood CAP in developing countries are categorized by WHO as definite, likely and possible. In developing countries, coal and biomass in the form of wood, dung and crop are commonly used residues for domestic energy. These materials are often burnt in simple stoves with very incomplete combustion. Consequently, young children, who often spend a large amount of time with their mothers doing household cooking, are exposed to high levels of indoor air pollution every day. There is consistent evidence that indoor air pollution increases the risk of chronic obstructive pulmonary disease and of acute respiratory infections in childhood. Exposure to smoke during cooking and parental smoking has also been associated with an increased risk of death from ALRI.

Table 5: Risk factors

Definite risk factors	Likely risk factors	Possible risk factors
Malnutrition (weight-for-age z-score < -2, <5 years of age)	Parental smoking	Mother's education
Low birth weight	Zinc deficiency	Day-care attendance
Non-exclusive breastfeeding (during the first 4 months of life)	Mother's experience as a caregiver	Rainfall (humidity)
Lack of measles immunization (within 12 months of life).	Concomitant diseases (e.g. diarrhea, heart disease, asthma)	High altitude (cold air)
Indoor air pollution		Vitamin A deficiency.
Crowding (defined as ≥5 people per household)		Birth order
		Outdoor air pollution

Table 6: Potential interventional areas for reducing pneumonia morbidity or mortality among less than 5 years old.[70]

Immunization	Improving Nutrition	Reducing Environment Pollution
Increased coverage Measles, pertussis Newer vaccines Pneumococcus H. influenza B, RSV Other viral vaccines	Breast feeding, LBW, Malnutrition, Severe Anemia	Indoor air pollution, Outdoor air pollution, Environmental, Tobacco smoke
Case management and Chemoprophylaxis	**Reducing transmission of Pathogens**	**Improving child care practices**
Severely malnourished children, high risk neonates, acute upper respiratory infection	Crowding, direct transmission, HIV	Care seeking, maternal education, child spacing

The treating clinician needs to be aware of these risk factors to allow appropriate intervention. Mortality due to pneumonia may be prevented by recognizing these risk factors and early referral to hospitals for provision of appropriate care.

DIAGNOSIS

Radiology: [7, 64, 65, 71, 72]

The chest radiograph is a relatively good macroscopic representation of anatomy and aeration pattern of lungs and can depict the extent and distribution of pathologic process. The chest radiograph is highly sensitive, but not often specific for the cause, determination of the infecting organism should not be based only on radiographic findings.

Common radiological patterns of pneumonia:

In general, the pulmonary infections in infants and children tends to manifest itself on chest x-ray in one of the several ways.

1. Alveolar or air space disease is characterized by lobar or segmental consolidation and by presence of air bronchogram.
2. Interstitial pneumonia presents as increased bronchovascular markings, peribronchial cuffing and to some degree of over aeration.
3. Bronchopneumonia: diffuse bilateral pattern with increased peribronchial markings and small infiltrates that extents into the periphery.

The presence of foreign body, congenital malformation or asthma should be considered in the patients with recurrent pneumonia or atelectasis in the same area. Recurrences in the different areas may suggest immunodeficiency, aspiration or cystic fibrosis.

The radiographic characteristics of pulmonary infection in the children are many and varied. Although the typical patterns are helpful in the diagnosis, clinical and laboratory evaluations provides many important diagnostic information. An understanding of basic pathology of infection and appreciation of anatomy of the growing lung help to provide clearer insight and accurate radiological interpretation.

Role of ultrasonogram in pneumonia: [73]

Ultrasonography is primarily indicated in children with complications such as pleural effusion, and also in whom antibiotic treatment fails to elicit response. It is used to effectively differentiate between a low-grade effusion and a high-grade effusion. A meta-analysis by Pereda et al in 2015 summarized the evidences on the

diagnostic accuracy of lung ultrasound for pneumonia in childhood and concluded that the current evidence supports lung ultrasound as an imaging alternative for the diagnosis.

Laboratory diagnosis: [7, 64, 65]

Laboratory tests are performed to identify causal agents. Unfortunately there are no gold standards. The utility of most of laboratory tests is imputed from consensus and expert opinions. The inclusion of these tests in various settings is based on the availability and feasibility rather than on evidence that they will affect the change in management or follow up.

Non-invasive methods:

Complete white blood cell count (TC) and differential count (DC) may be useful for differentiation of viral from bacterial pneumonia. In bacterial pneumonia TC are in range of 15000-40,000/cu.mm with granulocytic predominance. In viral pneumonia, TC may be normal or may be elevated but not usually more than 20,000/cu.mm with a lymphocytic predominance. Leucopenia may be also seen in viral infection, however its presence in bacterial pneumonia suggests a severe or overwhelming infection.

The definite diagnosis of bacterial pneumonia requires isolation of the organism from blood, pleural fluid or from the lungs. Sputum culture is of no value in the diagnosis of pneumonia in children.

In children with significant effusion/empyema, examination of the pleural fluid/pus for gram staining, culture, pH, glucose, protein and lactate dehydrogenase (LDH) helps in establishing the diagnosis. The protein content of the fluid allows

differentiation between transudate (<3g/dl) and exudate (>3g/dl). The presence of pleural fluid glucose below 40mg/dl, LDH > 1000IU/L is associated with high risk of complications and requires placement of chest tube.

Invasive methods:

Lung puncture is the most sensitive method for recovery of and identification of bacterial pneumonia in children, but it is an invasive procedure and exposes the child to serious risks.

Bronchoalveolar lavage by flexible bronchoscopy should be considered in children with persistent infiltrate or not responding to empiric antibiotic therapy.

Serology:

Serology testing is only of limited value in the diagnosis of pneumonia because it is based on four fold or greater antibody rise between paired acute and convalescent sera that are collected weeks apart.

Latex agglutination / counter current immunoelectrophoresis:

These rapid tests to detect bacterial antigens in serum and urine have shown very poor sensitivity and specificity. Eg. Detection of bacterial antigens of S. pneumoniae and H. influenzae type B.

Atypical microorganisms:

The most readily available and useful serologic test for mycoplasma is the cold hemagglutinin assay (IgM). Titers of 1:64 or more is strongly suggestive of diagnosis. The definite diagnosis of chlamydia is achieved by isolation in cultures of specimens obtained from nasopharynx and conjunctiva. Antibodies against chlamydia from the serum can be detected using enzyme immunoassay.

Viral pneumonia:

The definitive diagnosis of viral infection rests on isolation of virus or detection of viral agents in the respiratory tract secretions. The serological techniques can be used to diagnose viral pneumonia.

MANAGEMENT OF PNEUMONIA:

General Management:

In children with severe respiratory distress, supplementary oxygen should be provided to keep the oxygen saturation above 92%.Adequate hydration should be maintained by using IV fluids if necessary. Antipyretics should be used to bring down fever.

Use of Antibiotics: [74]

Antibiotics are used in suspected bacterial pneumonia. Viral and bacterial pneumonia are often difficult to distinguish clinically as well as radiologically. It is also difficult to isolate the etiological agent by most of the tests described. So antibiotics are often started empirically. The choice of empirical antibiotics is based on the clinical features, prevalence of various organisms in different age groups, and regional variation in the pathogens.

Table 7: Antibiotics of choice in pneumonia

Etiological organism	First choice	Other
Pneumococcus	Penicillin, high-dose amoxicillin or ampicillin	Ceftriaxone, azithromycin, Cefuroxime
Penicillin resistant S. pneumoniae	Second or third generation cephalosporins for sensitive strains; Vancomycin	-----
Staphylococcus aureus	Methicillin/Oxacillin	Vancomycin, Teicoplanin
Haemophilus influenzae	Amoxicillin	cefuroxime, ceftriaxone, other second-and third generation cephalosporins, Amoxicillin/clavulanate
Moraxella catarrhalis	Amoxicillin/clavulanate	Cefuroxime

Table 8: Choice of antibiotic usage in different age groups[74]

Age/clinical picture	Inpatient	Outpatient
Newborn	Ampicillin or penicillin G + gentamicin	-----
3 weeks to 3 months, with interstitial infiltrate, not sick looking	Macrolides	Macrolides
4 months to 4 years	Penicillin or ampicillin; if not responding add macrolide.	Amoxicillin
Above 5 years with Alveolar infiltrate/ pleural effusion/ toxic appearance	Penicillin or ampicillin; if not responding add macrolide	-----
Necrotizing pneumoni	Oxacillin / nafcillin, Vancomycin [MRSA]. Consider adding third generation cephalosporin	-----

Antibiotic Dosages for the Treatment of Pneumonia: [74]

- Penicillin 100,000 U/kg/day, q4h or q6h (up to 400,000 U/kg/day for resistant strains) for 7-10 days
- Ampicillin100-200 mg/kg/day q6h for 7-10 days (IV), 50 mg/kg/day, q6h, for 7-10 days (PO)
- Amoxicillin 50 mg/kg/day, q8h or q12h, for 7-10 days (for resistant strains dose can be increased up to 100 mg/kg/day)
- Amoxicillin/clavulanate 40 mg/kg/day of amoxicillin for 7-10 days
- Cefuroxime Oral 30 mg/kg/day, q12h, for 5-7 days, 150 mg/kg/day, q8h, IV for 7-10 days

- Oxacillin/nafcillin 150 mg/kg/day, q6h, maximum 12 g/day, for 14-21 days
- Cefotaxime 200 mg/kg/day, q8h, for 7-10 days
- Ceftriaxone 50-75 mg/kg/day, bid, for 7-10 days
- Cefdinir 14 mg/kg/day, q12h, for 7-10 days
- Cefprozil 15-30 mg/kg/day, q12h, maximum 1 g/day, for 7-10 days
- Cefpodoxime proxetil 10 mg/kg/day, q12h, maximum 400 mg/day, for 7-10 days
- Erythromycin 40 mg/kg/day, q6h, for 5-7 days
- Clarithromycin 15 mg/kg/day, q12h, maximum 1 g/day, for 57 days
- Azithromycin Oral 10 mg/kg/day, qd, for 3-5 days
- Vancomycin 40-60 mg/kg/day, q6h, for 7-10 days (14-21 days for S. aureus)
- Gentamicin 7.5 mg/kg/day, q8h, for 7-10 days

Duration of antibiotic therapy

Duration of therapy depends on the organism causing pneumonia. Antibiotics should be given for 7-10 days or at least 5 days after the fever has subsided.

For group B streptococcus and gram negative bacilli a course of 7 to 10 days is recommended. For staphylococcal pneumonia, 3-6 weeks of antibiotic therapy is recommended. However the etiological agent is often not identified in most of the patients [65] for pneumonia complicated by empyema, pyopneumothorax or pneumatoceles may require prolonged treatment for 4 to 8 weeks.

Failure of antimicrobial therapy:

1. Revise the clinical or microbiological diagnosis
2. Ascertain appropriate antimicrobial sensitivity
3. Underlying complication
4. Infection at hidden site elsewhere
5. Immunocompetency of the affected child
6. Compliance of the host
7. Anatomical defect
8. Undetected foreign body
9. Resistance
10. Super infection with new organism.

MATERIALS & METHODS

MATERIALS AND METHODS

Study Design

Descriptive cross sectional study

Study Place

Sree Mookambika Institute of Medical Sciences, Kulasekharam.

Study Period

12 months

Number of groups studied: 1

Inclusion criteria:

- Children of 2 months-15 years old who have cough and fast breathing on examination.

Exclusion criteria:

- Children with chronic respiratory illnesses such as cystic fibrosis or bronchopulmonary dysplasia, congenital anomalies of heart and lungs, children with anatomical defects like cleft lip and cleft palate.
- Children with illnesses that may predispose to pneumonia such as sickle cell anemia, immunosuppression and malignancy.
- Children for whom chest radiography was performed for indications other than evaluation for the presence of pneumonia, such as trauma or foreign body aspiration.
- Children whose caregivers/parents refused to give consent.

Sample size: 100

Sample size (n) =$\frac{4pq}{d^2}$

Where, p = prevalence (Percentage of patients with fast breathing having pneumonia)

q = 100 – prevalence

d = precision is 15%

Substituting in the formula, (n) =$\frac{4pq}{d^2}$

P =65%[43], Q=35

(n) =$\frac{4x65x35}{(9.75)^2}$ = $\frac{9100}{95}$ = 95.7

The sample size calculated was : 95.7

Rounded off to 100.

Sampling technique:

- Purposive sampling technique on consecutive cases.
- Ethical clearance was obtained from the institutional ethical committee.

METHODOLOGY:

All children in the age group 2 months – 15 years attending the emergency and out-patient department of the institution with cough and fast breathing were examined. Cases were selected based on the inclusion and exclusion criteria after getting informed written consent in local language from parents/caregivers and assent from the child. A detailed history regarding the present and past illnesses, socioeconomic status were taken and the children were examined in detail and the parents/caregivers were interviewed by the principal investigator.

Detailed history regarding cough, fast breathing, fever, wheezing, vomiting and refusal of feeds were taken. A thorough clinical examination was done for all selected cases. During the general physical examination, emphasis was laid on assessing the general condition of the child, axillary temperature was recorded for 3 minutes using digital thermometer, pulse rate was counted for one full minute, respiratory rate was counted for one full minute by observing the movement of the child's abdomen or chest Capillary refill time (CRT) was measured by pressing on the finger for five seconds using moderate pressure at room temperature, oxygen saturation was measured using pulse oximetry and other signs such as presence or absence of nasal flaring, grunting, pallor and cyanosis were noted.

A detailed examination of anthropometry of the child was carried out. Detailed systemic examination was done with special reference to respiratory system and was looked for signs like chest retractions, rhonchi and crepitations.

Other pertinent information such as immunization status, feeding practices and nutritional status was noted.

Routine blood investigations - Haemoglobin, Total Count, Differential Count, and C - reactive protein were done.

All children underwent chest radiography using standard equipment and radiological techniques. All radiographs were reviewed independently by two different paediatricians, who were blinded regarding patient details. The chest radiographs were interpreted according to chest radiograph interpretation document, for WHO trialists group.

DEFINITIONS:

Fever:

Fever is defined as a rectal temperature ≥38°C (100.4°F).[75] Child is considered to have fever if the axillary temperature is > 37.5 degree celsius according to IMNCI guidelines. In our study, we recorded the history of fever and presence of fever was documented if the axillary temperature ≥ 37.5^{o}C.

Cough:

Act of coughing is a reflex aimed at removal of mucous and other materials from the airways that follows the stimulation of cough or irritant receptors.

Tachypnea: [43, 76]

Tachypnea is defined as the respiratory rate measured by observing the chest or the abdomen of the child for one whole minute is

- 60 or more breaths per minute in infants younger than 2 months,
- 50 breaths or more for infants from 2months to 12 months,
- 40 breaths per minute or more for children from12 months to 59 months,
- 30 breaths per minute or more for children from 5years to 10 years,
- 24 breaths per minute or more for children from 11 years to 15 years.
- All children in our study had cough and fast breathing. Only children with cough and fast breathing were included in our study.

Wheezing:

Wheezing is a musical, low pitched or high pitched sighing or whistling sound heard often during expiration. This sound is due to obstruction of lower

airways especially the smaller airways. In our study, the history of wheeze was recorded as present or absent.

Nasal flaring:

Nasal Flaring refers to the enlargement of the nostrils with each inspiratory breath. In our study, it was recorded as present or absent.

Grunting:

Grunting is a short low pitched sound heard during expiration. Grunting occurs when the child exhales against a partially closed glottis. In our study, it was recorded as present or absent.

Chest Retractions:

Chest retractions are the inward movement of the soft tissues of the chest wall or sternum during inspiration. Chest retractions are a sign that the child is trying to move the air into the lungs by the increased use of chest wall muscles. In our study, it was recorded as present or absent.

Crepitations:

Crepitations or crackles also called as rales, are sharp, crackling sounds heard often during inspiration. In early pneumonia crackles are heard in mid inspiration and in recovery phase crackles are heard during end expiration. In our study, it was recorded as present or absent.

Malnutrition: [77]

Malnutrition refers to deficiencies, excesses, or imbalances in person's intake of energy or nutrients.

The term malnutrition addresses

1. Undernutrition – wasting, stunting and underweight
2. Micronutrient related malnutrition
3. Overweight, obesity and diet related diseases

In this study, we defined nutritional status by calculating wasting (WFH) and children were classified either as normal or malnourished (wasted).

Wasting in children is a symptom of acute undernutrition, usually as a consequence of insufficient food intake or a high incidence of infectious diseases.

Wasting in turn impairs the functioning of the immune system and can lead to increased severity and duration of and susceptibility to infectious diseases and an increased risk for death.

Wasting: weight for height < –2 SD of the WHO Child Growth Standards median.

Haemoglobin, total count and differential count were measured using automated machine, C-reactive protein was measured by immuno-turbidimetry method.

Anemia: [78]

Anemia is defined as the condition in which the number of red blood cells or their oxygen carrying capacity is insufficient to meet physiologic needs, which vary by age, sex, altitude, smoking and pregnancy status.

The hemoglobin levels to diagnose Anaemia at sea level for different age group is as follows in g/l according to WHO is as follows:

Table 9: WHO cutoff for anemia in different age groups

Population	Anaemia		
	Mild	Moderate	Severe
6 months – 59 months	100-109	70-99	< 70
5 years – 11 years	110-114	80-109	<80
12 years – 14 years	110-119	80-109	<80
Non-pregnant women (15 years and above)	110-119	80-109	<80
Men (15 years and above)	110-129	80-109	<80

In our study, anemia was recorded as present or absent.

LEUKOCYTOSIS: [79]

Leukocytosis is increase in the number of circulating White Blood Cell count more than normal for that age group. It usually results from an infection. There are several types of WBCs, each with different disease fighting activity. They are neutrophils, lymphocytes, monocytes, basophils and eosinophils.

Table 10: Normal range of leukocyte count in children

Age Group	Normal Leukocyte count [X 1,000 cells/mm3 (µL)]
1 - 23 months	6.0 - 14.0
2 - 9 years	4.0 - 12.0
10 - 17 years	4.0 - 10.5

In our study, it was recorded as present or absent.

C- REACTIVE PROTEIN: [80]

C - reactive protein is an acute phase protein produced by liver. It is an important component of nonspecific innate immune system response to infection and injury. CRP levels increases quickly in 24-72 hours following infection and injury. They remain elevated for roughly one week after resolution of infection. Several studies have found higher CRP levels in bacterial than viral infections. In our study, CRP was recorded as present (positive) or absent (negative).

DIAGNOSTIC DEFINITION OF RADIOGRAPHIC PNEUMONIA [81]

According to Chest radiograph interpretation document, for WHO trialists group, the chest radiograph findings are classified as

Significant pathology:

This refers specifically to the presence of consolidation, infiltrates or effusion. If none of these are present then no further reading or recording is required for that film.

End-point consolidation:

A dense opacity that may be a fluffy consolidation of a portion or whole of a lobe or of the entire lung, often containing air bronchograms and sometimes associated with pleural effusion.

Other (non-end-point) infiltrate:

Linear and patchy densities (interstitial infiltrate) in a lacy pattern involving both lungs, featuring peribronchial thickening and multiple areas of atelectasis. Lung inflation is normal to increased. It also includes minor patchy infiltrates that are not of sufficient magnitude to constitute primary end-point consolidation, and small

areas of atelectasis which in children can be difficult to distinguish from consolidation.

Pleural effusion:

This refers to the presence of fluid in the pleural space between the lung and chest wall. In most cases this will be seen at the costo-phrenic angle or as a layer of fluid adjacent to the lateral chest wall. This does not include fluid seen in the horizontal or oblique fissures. Pleural effusion is considered as primary end-point if it is in the lateral pleural space (and not just in the minor or oblique fissure) and is spatially associated with a pulmonary parenchymal infiltrate (including other infiltrate) OR if the effusion obliterates enough of the hemithorax to obscure an opacity.

The quality of the X-ray film is classified as

Uninterpretable:

An image is classified as uninterpretable if the features of the film are uninterpretable in terms of presence or absence of primary end-point without any additional images. No further reading is done in such images.

Suboptimal:

Here, the features in the film allow interpretation of primary end-point but not of any other findings.

Adequate:

An image is classified as an adequate one if the features of the film allow confident interpretation of end-point as well as other findings and infiltrates.

In our study,

Pneumonia was presence of significant pathology that is, presence of end point consolidation or other infiltrate or pleural effusion in the chest X-ray.

No pneumonia was absence of significant pathology in the chest X-ray.

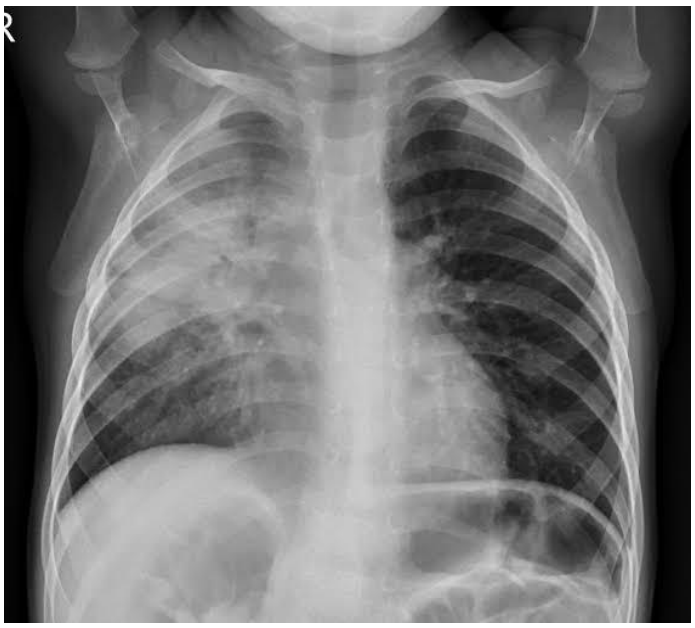

Fig. 1: Chest X-ray showing a dense non-homogeneous opacity (End Point Consolidation) noted in upper and middle zones of the right lung

STATISTICAL ANALYSIS

- Descriptive statistics were represented by frequency and percentages.
- Inferential statistics were done using Chi square test for bivariate analysis and binominal logistic regression for multivariate analysis.
- The significance level was decided as 95% and P value <0.05 was considered significant.
- Software used for data entry: Microsoft Excel 2013.
- Software used for statistical analysis: SPSS version 20.

RESULTS

RESULTS

OBSERVATIONS:

A total of 100 children with cough and fast breathing were studied in the age group 2 months to 15 years.

Demographic characteristics in the study population

- Total no. of males = 64 (64%)
- Total no. of females = 36 (36%)

Table 11: Age and sex distribution in the study population

Age Categories	Sex		Total
	Male	Female	
2 months - 1 year	17 (17%)	10 (10%)	27 (27%)
1 - 5 years	33 (33%)	15 (15%)	48 (48%)
6 - 10 years	9 (9%)	8 (8%)	17 (17%)
11 - 15 years	5 (5%)	3 (3%)	8 (8%)
Total	64 (64%)	36 (36%)	100 (100%)

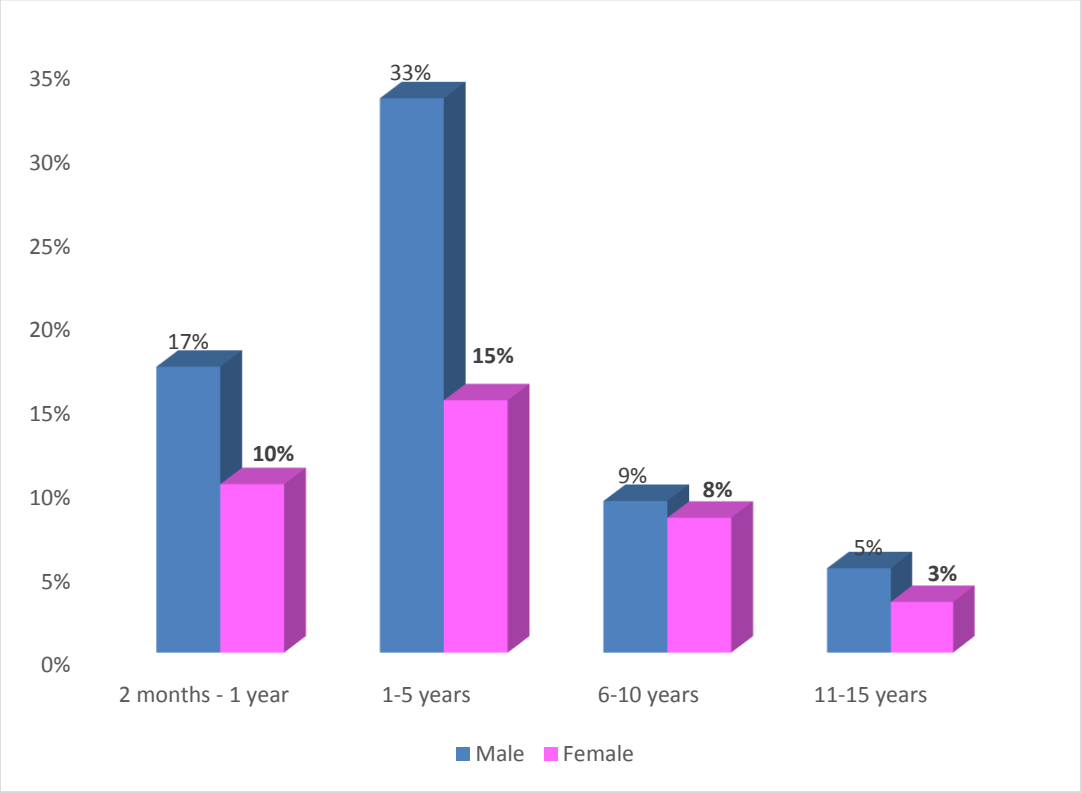

Fig. 2: Age and Sex Distribution in the study population

Our study population comprised of 64% males and 36% females. In our study 27% children were in 2 months to 1 year, 48% in 1 – 5 years, 17% in 6 – 10 years and 8 in 11 – 15 years. Majority of the children were in the age group 1 – 5 years.

Table 12: Distribution of clinical parameters in the study population

Clinical parameters		N	%
H/o fever	Present	78	78.0%
	Absent	22	22.0%
H/o Wheeze	Present	42	42.0%
	Absent	58	58.0%
Vomiting	Present	25	25.0%
	Absent	75	75.0%
Refusal of Feeds/fluids	Present	48	48.0%
	Absent	52	52.0%

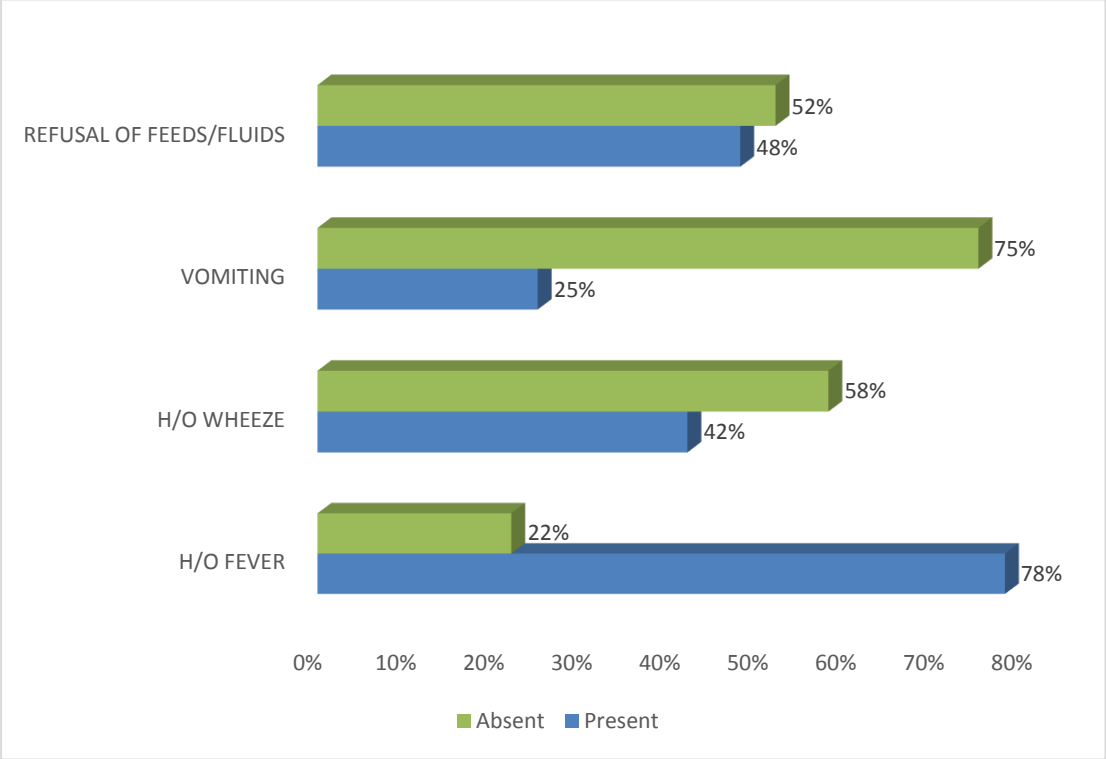

Fig. 3: Distribution of clinical parameters in the study population

History of fever was present in 78% of children. History of fever was absent in 22% of children. History of refusal of feeds/fluids and vomiting were seen in 48% and 25% of children respectively. History of wheeze was present and absent in 42% and 58% of children respectively. The most common symptom in our study population was presence of history of fever, followed by presence of refusal of feeds/fluids.

Table 13: Age wise distribution of clinical parameters in the study population:

Clinical Parameters		Age Categories							
		2 months - 1 yr		1 - 5 yrs		6 - 10 yrs		11 - 15 yrs	
		N	%	N	%	N	%	N	%
H/o fever	Present	18	66.7%	39	81.3%	15	88.2%	6	75.0%
	Absent	9	33.3%	9	18.8%	2	11.8%	2	25.0%
H/o Wheeze	Present	2	7.4%	28	58.3%	7	41.2%	5	62.5%
	Absent	25	92.6%	20	41.7%	10	58.8%	3	37.5%
Vomiting	Present	2	7.4%	18	37.5%	4	23.5%	1	12.5%
	Absent	25	92.6%	30	62.5%	13	76.5%	7	87.5%
Refusal of Feeds/fluids	Present	16	59.3%	24	50.0%	7	41.2%	1	12.5%
	Absent	11	40.7%	24	50.0%	10	58.8%	7	87.5%

In the age group 2 months to 1 year, presence of history of fever, wheeze, vomiting and refusal of feeds/fluids were present in 66.7%, 7.4%, 7.4% and 59.3% of children respectively.

In the age group 1 year to 5 years, presence of history of fever, wheeze, vomiting and refusal of feeds/fluids were present in 81.3%, 58.3%, 37.5% and 50% of children respectively.

In the age group 6 years to 10 years, presence of history of fever, wheeze, vomiting and refusal of feeds/fluids were present in 88.2%, 41.2%, 23.5% and 41.2% of children respectively.

In the age group 11 years to 15 years, presence of history of fever, wheeze, vomiting and refusal of feeds/fluids were present in 75%, 62.5%, 12.5% and 12.5% of children respectively.

All the symptoms were seen commonly in the age group 1 – 5 years, since more children are present in this age group in our study population.

Table 14: Distribution of vital signs in the study population

Vital signs		N	%
Temperature ≥ 38^0 C	Present	63	63.0%
	Absent	37	37.0%
SpO2 < 95%	Present	51	51.0%
	Absent	49	49.0%

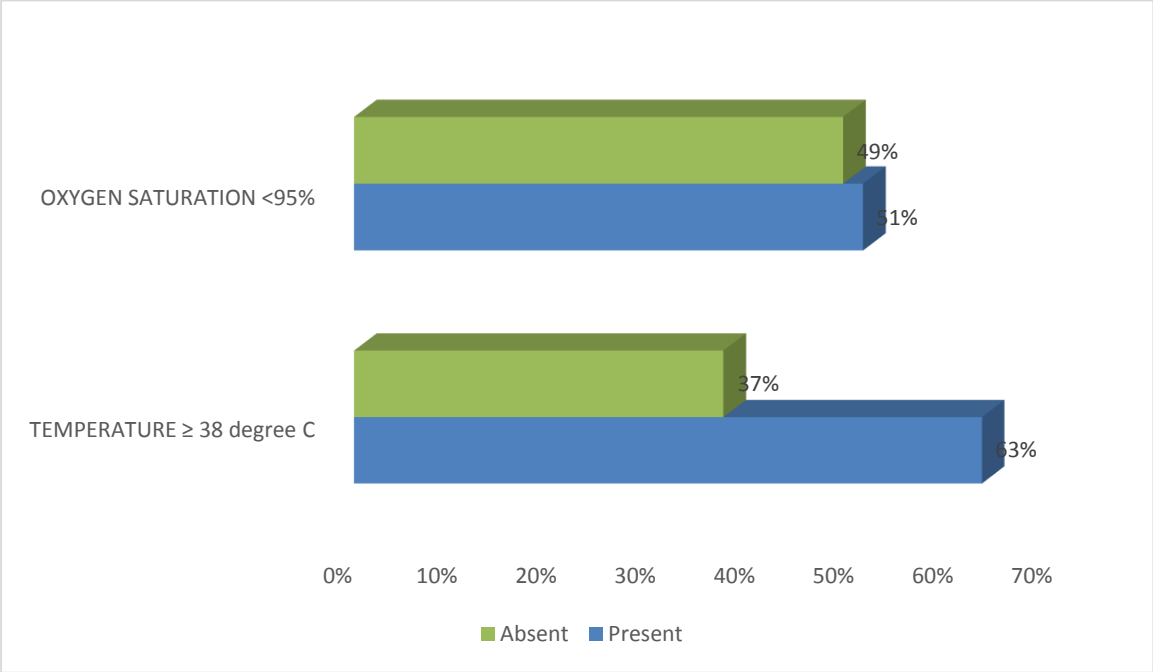

Fig. 4: Distribution of vital signs in the study population

At the time of examination, temperature was ≥ 38^0 C in 63% of children. Temperature was < 38^0 C in 37% of the population. 51% of children in the study population had oxygen saturation < 95%.

Table 15: Age wise distribution of vital signs among study population

Vital signs		Age Categories							
		2 months - 1 year		1 - 5 years		6 - 10 years		11 - 15 years	
		N	%	N	%	N	%	N	%
Temp ≥ 38° C	Present	18	66.7%	34	70.8%	8	47.1%	3	37.5%
	Absent	9	33.3%	14	29.2%	9	52.9%	5	62.5%
SpO2 < 95%	Present	18	66.7%	20	41.7%	9	52.9%	4	50.0%
	Absent	9	33.3%	28	58.3%	8	47.1%	4	50.0%

In the age group 2 months to 1 year, temperature ≥ 38^0 C and SpO_2 <95% were present in 66.7% and 66.7% of children respectively.

In the age group 1 year to 5 years, temperature ≥38^0 C and SpO_2 <95% were present in 70.8% and 41.7% of children respectively.

In the age group 6 years to 10 years, temperature ≥38^0 C and SpO_2 <95% were present in 47.1% and 52.9% of children respectively.

In the age group 11 years to 15 years, temperature ≥38^0 C and SpO_2 <95% were present in 37% and 50% of children respectively.

Table 16: Distribution of malnutrition in the study population

Malnutrition		N	%
Wasting	Present	36	36%
	Absent	64	64%

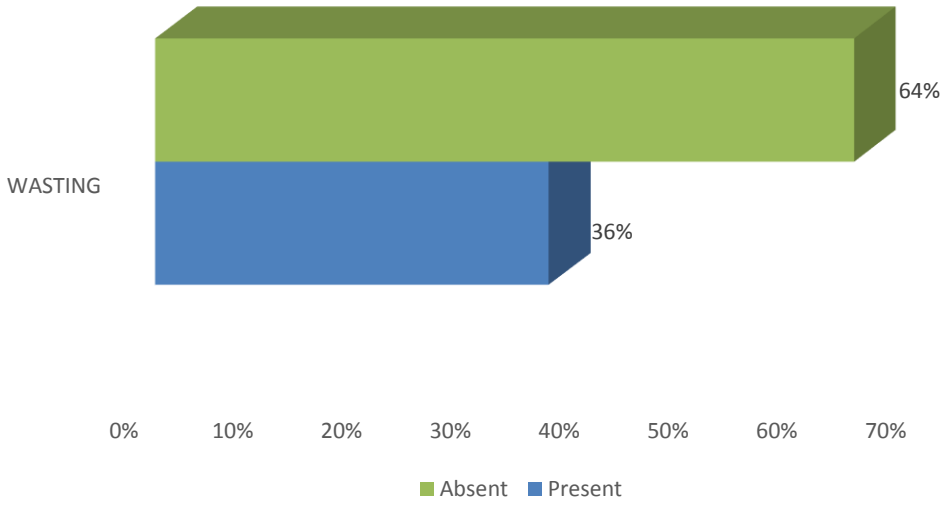

Fig. 5: Distribution of malnutrition in the study population

Malnutrition, as scored by wasting was present in 36% patients. No wasting was seen in 64% patients.

Table 17: Age wise distribution of malnutrition in the study population

Malnutrition		Age Categories							
		2 months - 1 year		1 - 5 years		6 - 10 years		11 - 15 years	
		N	%	N	%	N	%	N	%
Wasting	Present	8	29.6%	18	37.5%	6	35.3%	4	50.0%
	Absent	19	70.4%	30	62.5%	11	64.7%	4	50.0%

In the age group 2 months – 1 year, wasting was present in 29.6% children and absent in 70.4% children.

In the age group 1 – 5 years, wasting was present in 37.5% children and absent in 62.5% children.

In the age group 6 – 10 years, wasting was present in 35.3% children and absent in 64.7% children.

In the age group 11 – 15 year, wasting was present seen in 50% children and absent in 50% children.

Malnutrition, as scored by wasting was present maximum in the age group 1-5 years, with 37.5%. Malnutrition was absent in 70.4% of children in the age group 2 months to 1 year.

Table 18: Distribution of respiratory parameters in the study population

Respiratory parameters		N	%
Nasal Flaring	Present	64	64.0%
	Absent	36	36.0%
Grunting	Present	34	34.0%
	Absent	66	66.0%
Retractions	Present	45	45.0%
	Absent	55	55.0%
Crepitations	Present	42	42.0%
	Absent	58	58.0%
Rhonchi	Present	58	58.0%
	Absent	42	42.0%

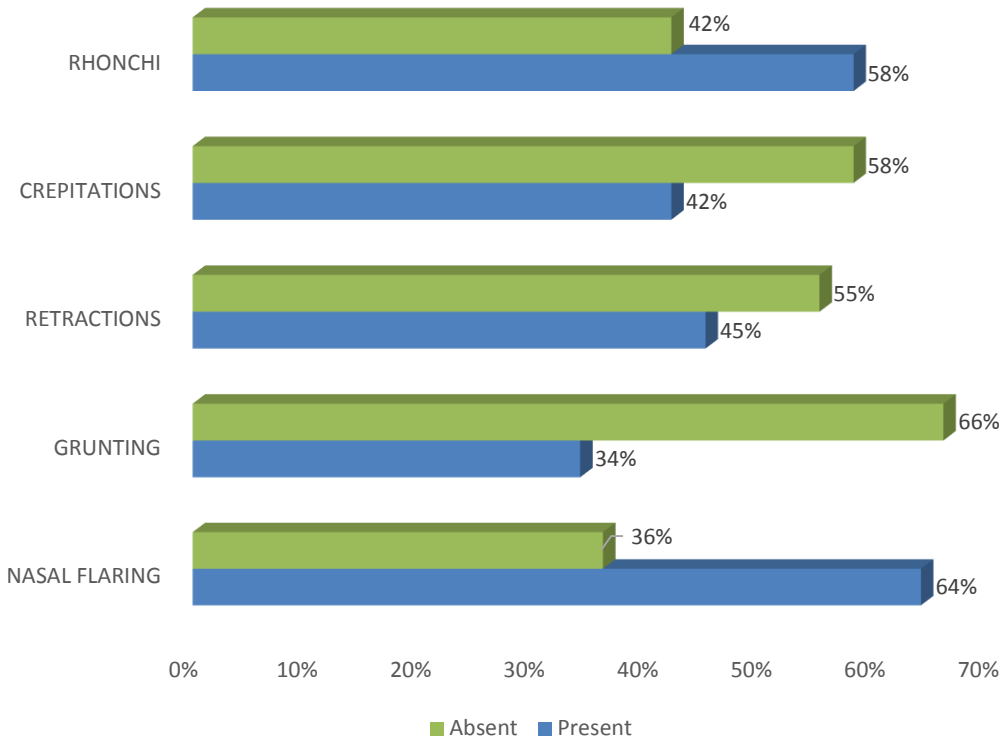

Fig. 6: Distribution of respiratory parameters in the study population

Nasal Flaring was present in 64% of children. On examination of the respiratory system, rhonchi was present in 58% of children, retractions and crepitations were present in 45% and 42% of children in the study population respectively. Grunting was present in 34% of children and absent in 56% (56) of children in the study population.

Table 19: Age wise distribution of respiratory parameters in the study population

Respiratory parameters		Age Categories							
		2 months - 1 year		1 - 5 years		6 - 10 years		11 - 15 years	
		N	%	N	%	N	%	N	%
Nasal Flaring	Present	19	70.4%	37	77.1%	6	35.3%	2	25.0%
	Absent	8	29.6%	11	22.9%	11	64.7%	6	75.0%
Grunting	Present	11	40.7%	18	37.5%	4	23.5%	1	12.5%
	Absent	16	59.3%	30	62.5%	13	76.5%	7	87.5%
Retractions	Present	13	48.1%	24	50.0%	6	35.3%	2	25.0%
	Absent	14	51.9%	24	50.0%	11	64.7%	6	75.0%
Crepitations	Present	10	37.0%	22	45.8%	8	47.1%	2	25.0%
	Absent	17	63.0%	26	54.2%	9	52.9%	6	75.0%
Rhonchi	Present	20	74.1%	28	58.3%	6	35.3%	4	50.0%
	Absent	7	25.9%	20	41.7%	11	64.7%	4	50.0%

In the age group 2 months to 1 year, nasal flaring and grunting were present in 77.1% and 37.5% of children respectively. Retractions was present in 48.1% of children. Crepitations and rhonchi were present in 37% and 74.1% of children respectively.

In the age group 1 year to 5 years, nasal flaring and grunting were present in 70.4% and 40.7% of children respectively. Retractions was present in 50% of children. Crepitations and rhonchi were present in 45.8% and 58.3% of children respectively.

In the age group 6 years to 10 years, nasal flaring and grunting were present in 35.3% and 23.5% of children respectively. Retractions was present in 35.3% of

children. Crepitations and rhonchi were present in 47.1% and 35.3% of children respectively.

In the age group 11 years to 15 years, nasal flaring and grunting were present in 25% and 12.5% of children respectively. Retractions was present in 25% of children. Crepitations and rhonchi were present in 25% and 50% of children respectively.

All the respiratory parameters were commonly seen in the age group 1-5 years, because of the increased number of study subjects in that age group.

Table 20: Distribution of laboratory parameters in study population

Laboratory parameters		N	%
Anemia	Present	55	55.0%
	Absent	45	45.0%
Leukocytosis	Present	60	60.0%
	Absent	40	40.0%
CRP	Present	24	24.0%
	Absent	76	76.0%

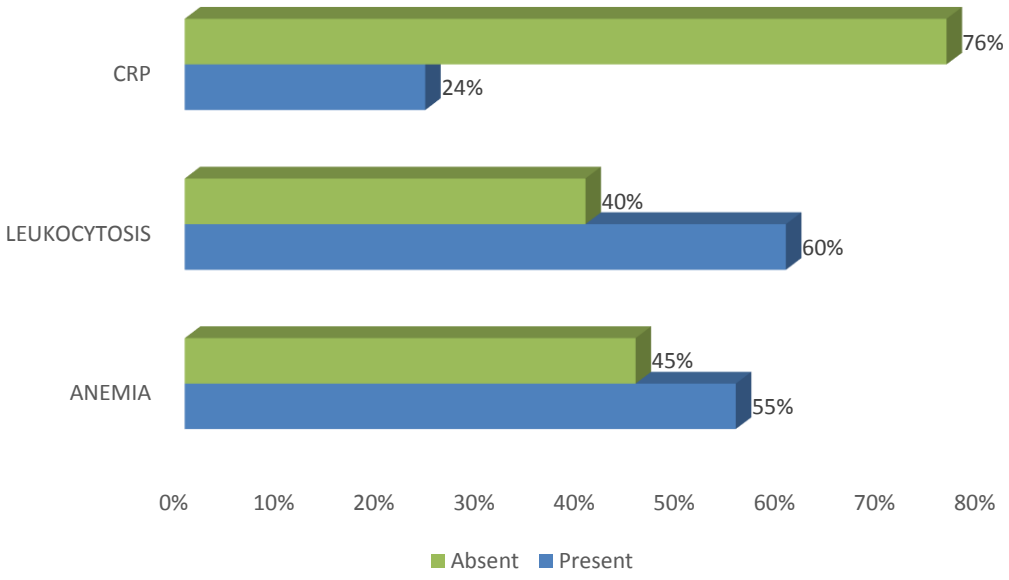

Fig. 7: Distribution of laboratory parameters in study population

Of the laboratory investigations done, anemia was present in 55% of children in the study population. Leukocytosis was present in 60% and absent in 40% of children in the study population. CRP was positive in 24% of children in the study population.

Table 21: Age wise distribution of laboratory parameters in the study population

Laboratory parameters		Age Group							
		2 months - 1 year		1 - 5 years		6 - 10 years		11 - 15 years	
		N	%	N	%	N	%	N	%
Anemia	Present	16	59.3%	32	66.7%	6	35.3%	1	12.5%
	Absent	11	40.7%	16	33.3%	11	64.7%	7	87.5%
Leukocytosis	Present	14	51.9%	30	62.5%	12	70.6%	4	50.0%
	Absent	13	48.1%	18	37.5%	5	29.4%	4	50.0%
CRP	Present	12	44.4%	10	20.8%	2	11.8%	0	0.0%
	Absent	15	55.6%	38	79.2%	15	88.2%	8	100.0%

In the age group 2 months to 1 year, anemia and leukocytosis were present in 59.3% and 51.9% of children respectively. CRP was positive in 44.4% of children.

In the age group 1 year to 5 years, anemia and leukocytosis were present in 66.7% and 62.5% of children respectively. CRP was positive in 20.8% of children.

In the age group 6 years to 10 years, anemia and leukocytosis were present in 35.3% and 70.6% of children respectively. CRP was positive in 11.8% of children.

In the age group 11 years to 15 years, anemia and leukocytosis were present in 12.5% and 50% of children respectively. CRP was not positive in this age group.

Positive CRP was found more in the age group 2 months to 1 year, with 44.4% children. CRP was negative in all the children > 10 years of age.

Table 22: Radiologically confirmed (CXR positive) Pneumonia in the study

Radiologically confirmed Pneumonia	Frequency	%
Present	44	44%
Absent (No pneumonia)	56	56%
Total	100	100%

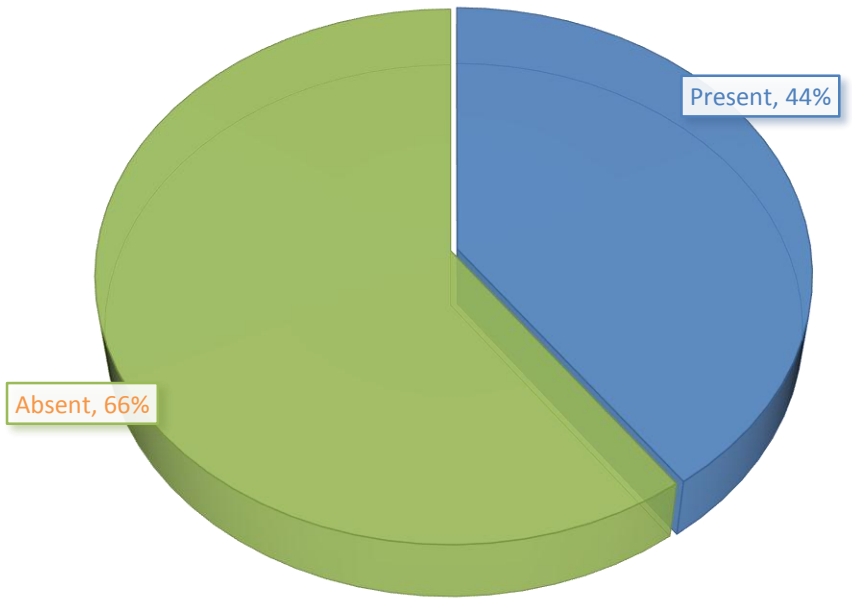

Fig. 8: Radiologically confirmed (CXR positive) Pneumonia in the study

Radiologically confirmed pneumonia was seen in 44% of children and no pneumonia in 56% of children.

Table 23: Age distribution in radiologically confirmed (CXR positive) Pneumonia

Age group	Pneumonia (N = 44)
2m-1y	10 (22.7%)
1y-5y	22 (50%)
6y-10y	9 (20.45%)
11y-15y	3 (6.8%)

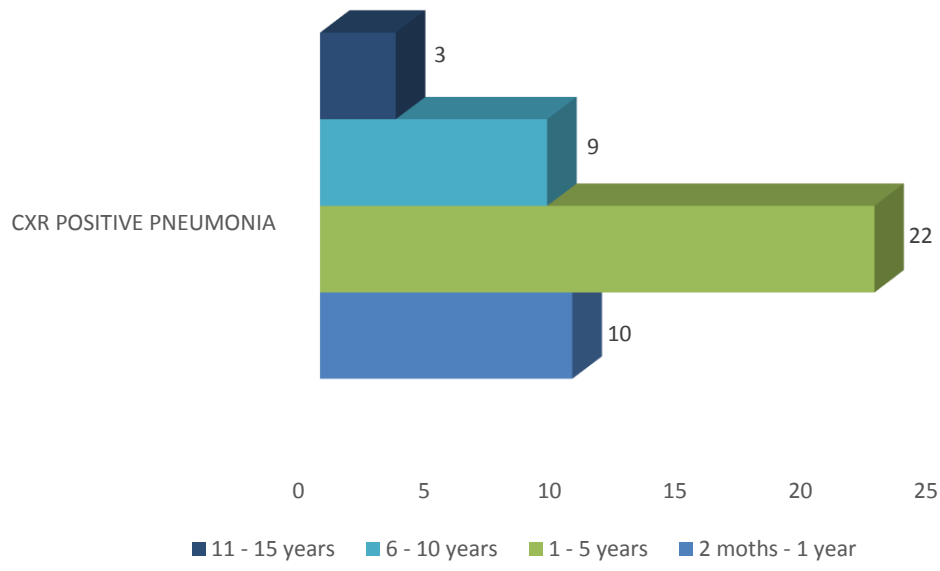

Fig. 9: Age distribution in radiologically confirmed (CXR positive) Pneumonia

In our study, the number of radiologically confirmed pneumonia was present more in the age group 1 – 5 years (22), followed by 2 months to 1 year (10).

Table 24: Prevalence of radiologically confirmed pneumonia in different age groups

Age group	Pneumonia (radiologically confirmed) N (%)	Study Population in each age group
2m-1yr	10 (37.03%)	27
1yr - 5yr	22 (45.83%)	48
6yr - 10yr	9 (52.94%)	17
11yr - 15yr	3 (37.50%)	8

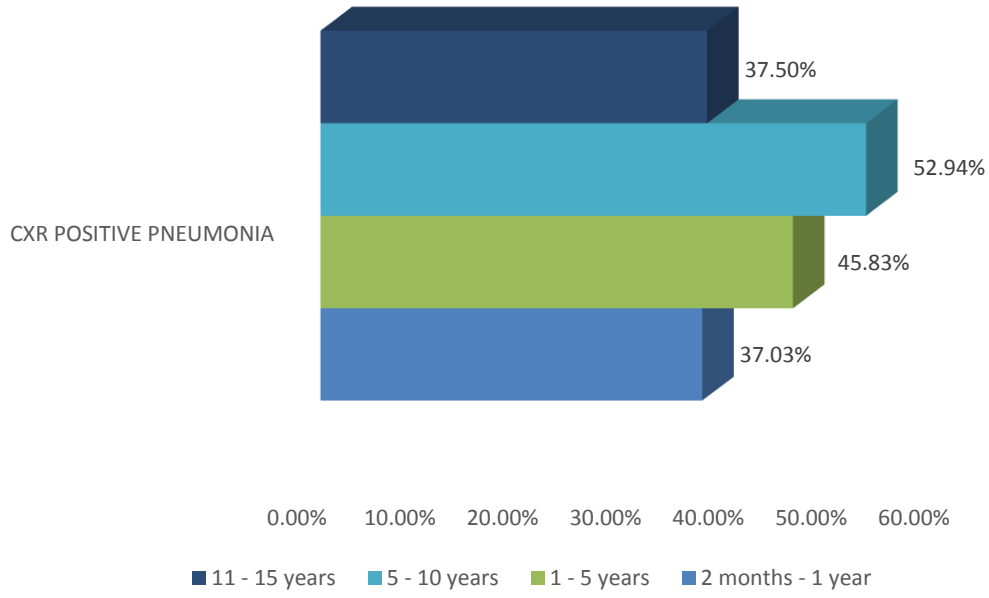

Fig. 10: Prevalence of pneumonia in different age groups

In our study, the prevalence of pneumonia in the age group 2 month to 1 year was 37.03%, 45.83% in the age group 1 to 5 years, 52.94% in the age group 6 to 10 years and 37.50% in the age group 11-15 years. The prevalence of pneumonia was present more in the age group 6-10 years and less in 2 months to 1 year.

Table 25: Distribution of sex in radiologically confirmed Pneumonia

Radiologically confirmed Pneumonia, Total	Male N (%)	Female N (%)
44	29 (65.90 %)	15 (34.10 %)

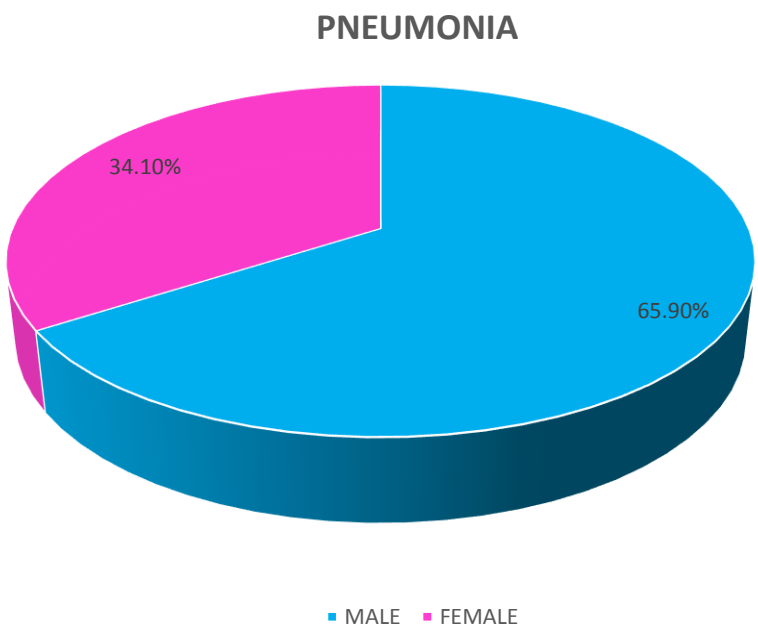

Fig. 11: Distribution of sex in radiologically confirmed Pneumonia

Of the radiologically confirmed pneumonia cases, 65.90 % were males and 34.10% were females. Majority of the radiologically confirmed pneumonia cases were males.

Table 26: Association of clinical parameters with pneumonia

Clinical parameters		Pneumonia (Radiologically confirmed)		No Pneumonia		P value
		N	%	N	%	
H/o fever	Present	39	88.6%	39	69.6%	0.023*
	Absent	5	11.4%	17	30.4%	
Vomiting	Present	7	15.9%	18	32.1%	0.063
	Absent	37	84.1%	38	67.9%	
Refusal of Feeds/fluids	Present	34	77.3%	14	25.0%	<0.001*
	Absent	10	22.7%	42	75.0%	

History of fever was found in 88.6% of the patients with pneumonia more than those without pneumonia (69.9%). History of refusal of feed/fluids was found in 77.3% of pneumonia patients and history of refusal of feeds/fluids was absent in 75% of the patients without pneumonia. History of fever and refusal of feeds/fluids are significantly associated with pneumonia with P values of <0.023 and <0.001 respectively. It was found that history of vomiting has got no significant association with pneumonia.

Table 27: Association of history of wheeze with pneumonia

		Pneumonia (Radiologically confirmed)		No Pneumonia		P value
		N	%	N	%	
H/o Wheeze	No	38	86.4%	20	35.7%	<0.001*
	Yes	6	13.6%	36	64.3%	

History of wheeze was present in 13.6% of pneumonia patients. No history of wheeze was seen in 86.4% of pneumonia patients. History of wheeze was present in 64.3% of patients with no pneumonia.

Presence of history of wheeze was significantly associated with no pneumonia ($P < 0.001$).

Table 28: Association of vital signs with pneumonia

Vital signs		Pneumonia (Radiologically confirmed)		No Pneumonia		P value
		N	%	N	%	
Temperature ≥ 38^0 C	Present	42	95.5%	21	37.5%	<0.001*
	Absent	2	4.5%	35	62.5%	
SpO_2 < 95%	Present	36	81.8%	15	26.8%	<0.001*
	Absent	8	18.2%	41	73.2%	

Presence of temperature ≥ 38^0 C was found in 95.5% of the pneumonia patients. Oxygen saturation < 95% was found in 81.8% of the pneumonia patients. Both temperature ≥ 38^0 C and Oxygen saturation < 95% are significantly associated with pneumonia with P value of <0.001.

Table 29: Association of malnutrition with pneumonia

Malnutrition		Pneumonia (Radiologically confirmed)		No Pneumonia		P value
		N	%	N	%	
Wasting	Present	28	63.65	8	14.3%	<0.001*
	Absent	16	36.4%	48	85.7%	

Malnutrition as scored by wasting was present in 63.5% of the pneumonia patients and was absent in 85.7% of the patients with no pneumonia. The presence of wasting was significantly associated with pneumonia with P value of <0.001.

Table 30: Association of respiratory parameters with pneumonia

Respiratory parameters		Pneumonia (Radiologically confirmed)		No Pneumonia		P value
		N	%	N	%	
Nasal Flaring	Present	35	79.5%	29	51.8%	0.004*
	Absent	9	20.5%	27	48.2%	
Grunting	Present	31	70.5%	3	5.4%	<0.001*
	Absent	13	29.5%	53	94.6%	
Retractions	Present	37	84.1%	8	14.3%	<0.001*
	Absent	7	15.9%	48	85.7%	
Crepitations	Present	38	86.4%	4	7.1%	<0.001*
	Absent	6	13.6%	52	92.9%	

Nasal flaring was found in 79.5% and absent in 20.5% of pneumonia patients. Presence of nasal flaring was significantly associated with pneumonia with P value of 0.004.

Grunting was present in 70.5% and absent in 29.5% of pneumonia patients. Presence of grunting was significantly associated with pneumonia with P value of <0.001.

Chest retractions was present in 84.1% and absent in 15.9% of pneumonia patients. Presence of grunting was significantly associated with pneumonia with P value of < 0.001.

Crepitations was present in 86.4% and absent in 13.6% of pneumonia patients. Presence of grunting was significantly associated with pneumonia with P value of <0.001.

All the three parameters were significantly associated with pneumonia with P value of <0.05.

Table 31: Association of rhonchi with pneumonia

		Pneumonia (Radiologically confirmed)		No Pneumonia		P value
		N	%	N	%	
Rhonchi	Absent	28	63.6%	14	25.0%	<0.001*
	Present	16	36.4%	42	75.0%	

Rhonchi was present in 36.4% of pneumonia patients. It was absent in 63.6% of pneumonia patients. Rhonchi was present in 75.0% of the patients with no pneumonia.

The presence of rhonchi on examination was significantly associated with no pneumonia (P <0.001)

Table 32: Association of laboratory parameters with pneumonia

Laboratory parameters		Pneumonia (Radiologically confirmed)		No Pneumonia		P value
		N	%	N	%	
Anemia	Present	32	72.7%	23	41.1%	0.002*
	Absent	12	27.3%	33	58.9%	
Leukocytosis	Present	27	61.4%	33	58.9%	0.805
	Absent	17	38.6%	23	41.1%	
CRP	Present	13	29.5%	11	19.6%	0.25
	Absent	31	70.5%	45	80.4%	

Anemia was present in 72.7% of the pneumonia patients. Leukocytosis was present in 58.9% of patients with no pneumonia and seen only in 61.4% of the pneumonia patients. CRP was found negative in 70.5% of the pneumonia patients and only 29.5% pneumonia patients are CRP positive.

The presence of anemia was significantly associated with pneumonia with a P value of 0.002. Leukocytosis and raised CRP had got no significant association with pneumonia.

Radiologically confirmed pneumonia was present in 44 patients (44%) out of 100 patients in the study population. On comparing the clinical features of patients with and without pneumonia in the age group of 2 months -15 years, history of fever (p=0.023), refusal of feeds/fluids (p=<0.001), temperature $\geq 38^0$ C (p value=<0.001), oxygen saturation <95% (p value 0.001), presence of malnutrition (wasting) (p=<0.001), nasal flaring (p=0.004), grunting (p=<0.001), retractions (p=<0.001), crepitations (p=<0.001), and presence of anemia (p=0.002) were found to be significantly associated with radio pneumonia.

Table 33: Sensitivity, specificity, positive predictive value and Likelihood ratio of the variables.

For predicting Pneumonia	Sensitivity	Specificity	Positive Predictive value	Likelihood ratio
H/o fever	88.64%	30.36%	50.00%	1.27
H/o Wheeze	13.64%	35.71%	14.29%	0.21
Vomiting	15.91%	67.86%	28.00%	0.5
Refusal of Feeds/fluids	77.27%	75.00%	70.83%	3.09
Temperature $\geq 38^0$ C	95.45%	62.50%	66.67%	2.55
$SpO_2 < 95\%$	81.82%	73.21%	70.59%	3.05
Malnutrition	63.64%	85.71%	77.78%	4.45
Nasal Flaring	79.55%	48.21%	54.69%	1.54
Grunting	70.45%	94.64%	91.18%	13.14
Retractions	84.09%	85.71%	82.22%	5.88
Crepitations	86.36%	92.86%	90.48%	12.1
Rhonchi	36.36%	25.00%	27.59%	0.48
Anemia	72.73%	58.93%	58.18%	1.77
Leukocytosis	61.36%	41.07%	45.00%	1.04
CRP	29.55%	80.36%	54.17%	1.5

The significant parameters in our study, presence of history of fever, refusal of feeds/fluids, temperature ≥ 38^0 C, oxygen saturation < 95%, nasal flaring, grunting, chest retractions, crepitations, presence of malnutrition (wasting) and presence of anemia had got sensitivity of 88.64%, 77.27%, 95.45%, 81.82%, 79.55%, 70.45%, 84.09%, 86.36%, 63.64% and 72.73% respectively in predicting pneumonia in children. The parameters with high specificity are presence of malnutrition, grunting, chest retractions and crepitations. They were shown in the table 33.

In our study, the likelihood ratio of grunting and crepitations were 13.14 and 12.10 respectively, which implies Children who had grunting are 13 times more likely to have pneumonia than children without grunting and children with crepitations are 12 times more likely to have pneumonia than children without crepitations.

The presence of history of wheeze and presence of rhonchi had got sensitivity of 13.64% and 36.36% respectively in predicting pneumonia in children. History of wheeze and presence of rhonchi were commonly associated with no pneumonia.

In our study, the presence of temperature ≥ 38^0 C had got highest sensitivity of 95.45% in predicting pneumonia. The presence of grunting had got highest specificity of 94.64%. The presence of grunting had got highest positive predictive value of 91.18%. The variable with high likelihood ratio of getting pneumonia was grunting with 13.14. The variables having both high sensitivity and specificity for detecting pneumonia were presence of history of refusal of feeds/fluids, oxygen saturation <95%, presence of grunting, retractions and crepitations.

The positive predictive value and likelihood ratios all the variables were shown in the table 33.

Table 34: Binomial Logistic Regression for predicting Pneumonia in children aged 2 months – 15 years

	B	S.E.	Wald	df	P value	Adj Odds	95% C.I.for EXP(B)	
							Lower	Upper
Temperature $\geq 38^0$C	5.30	1.60	10.93	1.00	0.0009	200.03	8.64	4628.41
Malnutrition	4.26	1.43	8.85	1.00	0.0029	70.76	4.28	1170.43
Crepitations	4.82	1.35	12.84	1.00	0.0003	123.95	8.88	1730.42

After binominal logistic regression, we found that presence of temperature $\geq 38^0$ C, crepitations and presence of malnutrition (wasting) were independent predictors of developing pneumonia in all age groups in this study. Of them, temperature $\geq 38^0$ C is the strongest independent predictor of pneumonia with an Adjusted Odds Ratio of 200.03.

DISCUSSION

DISCUSSION

This is a descriptive study conducted in children of 2 months to 15 years of age with cough and fast breathing on examination.

In our study, radiologically confirmed pneumonia was present more in children aged less than 5 years. Out of 44 cases of pneumonia (radiologically confirmed), 50% (22) were in the age group 1 to 5 years, 22.7% (10) were in the age group 2 months to 1 year and 20.4% (9) were 6 – 10 years. The percentage of children with radiologically confirmed pneumonia in different age groups were 37.03% in the age group 2 months to 1 year, 45.83% in 1 – 5 years old children, 52.94% in 6 – 10 years old children and 37.5% in 11 -15 years old children. It was present more in the age group 6 – 10 years. This decreased prevalence in the age group 2 months to 1 year than the elder age groups may be due to the exclusive breastfeeding practices in the infancy. Evidences showed that breastfeeding protects the infants against infection and has a protective factor for reducing the risk of respiratory illness among infants.[82, 83] Our study was contrary to the findings of the study done by Abuka et al[84], where they found that pneumonia was seen more in children of age group 2-12 months, and also found that this age group was one of the determinants of pneumonia. Our study was also contrary to the study conducted by Bony Mathews[43], where they found no age predilection to develop pneumonia.

In our study, we found that the prevalence of pneumonia was more in 6 – 10 years than the under five children. This implies that the cough and fast breathing which were used to identify pneumonia cases in less than 5 year old children can

also be used to identify pneumonia in more than 5 years old children presenting with cough and fast breathing.

There was a male preponderance (64%) in our study with a male to female ratio of 1.77:1. There was a male predilection to develop pneumonia in our study with a male to female ratio in patients with radiographic pneumonia was1.93:1. This increased tendency of the male children to develop pneumonia was consistent with the study done by Falgas et al[85]. According to their study males are more susceptible than females to most types of RTIs in all age groups. Anatomic, behavioral, lifestyle, and socioeconomic differences between males and females may explain these findings. The role of sex hormones in the regulation of immune system may also contribute to the reported sex differences in the incidence and severity of various types of respiratory tract infections.

In our study, radiologically confirmed pneumonia was present in 44 (44%) out of the 100 children in the study population, these results are similar to the finding of Al-Najjar et al[38] with 42.4%, Nizam et al[86] with 50% and Goel et al[55] with 45.2% of radiographic pneumonia. It also agrees with Wilkin's study[87], where chest X-rays were frequently negative in patients suspected of having pneumonia.

Table 35: Comparison of incidence of radiographic pneumonia between studies

Study	Radiographic pneumonia
Al-Najjar et al	42.4%
Goel et al	45.2%
Nizam et al	50%
Present study	44%

We found that the presence of history of fever, history of refusal of feeds/fluids, temperature ≥ 38^0 C, oxygen saturation < 95%, presence of malnutrition (wasting), presence of nasal flaring, grunting, retractions, crepitations and anemia are found to be statistically significant factors associated with radiographic pneumonia.

The independent predictors of pneumonia by binominal logistic regression analysis in our study were temperature ≥38^0 Celsius, crepitations, and presence of malnutrition (wasting). Among them, temperature ≥ 38 degree Celsius has the strongest accuracy of predicting pneumonia in our study.

Goel et al[55] showed that the incidence of radiographic pneumonia in their study were 45.2% (113/250) in age group 2 months to 5 years. They concluded that the presence of tachypnea, pallor, retractions, nasal flaring, grunt, decreased breath sounds and crepitations were the main indicators of Acute Lower Respiratory tract infection confirmed by chest X-ray. Our study was also consistent with their study except that tachypnea and decreased breath sounds were not studied in ours, the other variables which we studied were significantly associated with radiographic pneumonia.

Lynch et al[37] in their study conducted in 1- 16 years old children found that the prevalence of pneumonia was 35.7% (204/571). They identified multiple predictive factors for children with suspected pneumonia. Patients with focal infiltrates were more likely to have history of fever, tachypnea, tachycardia, grunting, retractions, crackles and decreased breath sounds. Our study showed similar results compared to their study, except that tachycardia and decreased breath sounds were not evaluated.

Silayach J et al[51] showed that the incidence of radiographic pneumonia in their study was 26.7% with maximum number of cases among the youngest age group of 2 months to 11 months. They concluded that presence of radiographic pneumonia were predicted by clinical presence of decreased breath sounds and crepitations. In our study also crepitations was strongly associated with pneumonia with a significant P value of <0.001.

In our study, history of fever had a sensitivity of 88.64%, specificity of 30.3% and PPV of 50%. It was similar to the study done by Lynch et al[37], where fever had got sensitivity of 92%, sensitivity of 20% and PPV of 39%. History of fever was one of the significant predictors of pneumonia in their study, which was similar to our study in which history of fever was significantly associated with pneumonia with a P value of 0.023 and a likelihood ratio of 1.27.

In a study done by Mathew et al[43], they found that the incidence of radiographic pneumonia among children with wheezing was low (4.9%). The routine use of chest X-ray for children with wheezing but without fever should be discouraged. These findings were similar to our study. In our study, history of wheeze had got a low sensitivity and specificity of 13.6% and 35.7% respectively. The presence of history of wheeze had got a low PPV and Likelihood ratio of having pneumonia. The presence of wheeze in children with cough and fast breathing was associated with no pneumonia (P< 0.001).

The presence of refusal of feeds/fluids was strongly associated with the presence of radiographic pneumonia in our study. The sensitivity and specificity are 77% and 75% respectively, with a significant P value of <0.001. This was in

contrary to the study done by Silayach et al[51], where refusal of feeds was not significantly associated with pneumonia.

In our study, presence of temperature ≥ 38^0 C had the highest sensitivity of 95.4% and a specificity of 62.5%. The likelihood ratio was 2.55 with a PPV of 66.67%. It was significantly associated with pneumonia with a P value of < 0.001 and one of the independent predictors of pneumonia. These findings were similar to studies done by Al-Najjar et al[38] with sensitivity of 87.4% and specificity 60.9%. It also agrees with the findings of the studies done by Zukin et al[27], Shamo'ons et al[88] and Juven et al[89].

Coming to oxygen saturation, in our study oxygen saturation <95% measured by pulse oximetry was significantly associated with radiographic pneumonia. It had got a good sensitivity and specificity of 81.85% and 73.21% respectively, PPV of 70.5% and P value <0.001. It was similar to the study done by Lozano et al[29], who found a specificity of 83% and sensitivity of 73%. They concluded that presence of hypoxemia is the best predictor when the auscultatory findings are excluded.

Goel et al[55] found that the presence of nasal flaring had got a good sensitivity of 76.99% in predicting pneumonia in children, with a PPV and NPV of 50% and 65.7% respectively. Silayach et al[51] also found significant association of nasal flaring with pneumonia with a P value of 0.038 and Pepin et al[90] also found similar association. These all studies were similar to our study, our study showed sensitivity of 79.55% and was significantly associated with pneumonia with a P value of 0.004.

In our study, grunting had got a sensitivity of 70.45% and specificity of 94.64% in predicting pneumonia in children. The PPV of grunting was 91.18% and the likelihood ratio was 13.14. Children who had grunting are 13 times more likely to have pneumonia then those children without grunting. We found that grunting was significantly associated with pneumonia with a P value of <0.001. The findings in our study were similar to the study done by Silayach et al[51] who showed that grunt had a strong correlation with chest findings with a P value of <0.001. Lynch et al[37] also found the same result with P value of 0.038 which was similar to our study.

Al-Najjar et al[38] showed that chest retractions were present in 80% of pneumonic children with sensitivity and specificity of 80% and 88.2% respectively with a P value of 0.000. They found a significant relationship between chest retractions and pneumonia. Domecq et al[91] showed a positive Likelihood ratio of 2.49, Palafox[92] showed it has a significant correlation with a P value of 0.004. These findings are similar to our study. In our study presence of chest retractions had got a sensitivity and specificity of 84% and 85.7% respectively in predicting pneumonia in children. It was associated significantly with pneumonia with a P value of <0.001. The presence of chest retraction had got a likelihood ratio of 5.88 in predicting pneumonia in children, which means children with chest retractions were 5 times more likely to have pneumonia than children without chest retractions.

Gupta et al[31] showed that crepitations was found to have good correlation with radiographic pneumonia with a sensitivity and specificity of 81% and 99% respectively. The PPV and NPV are 97% and 94% respectively. Lynch et al[37] also found good correlation with P value of 0.001. These studies are similar to our study, we got a sensitivity and specificity of 86.3% and 92.8% respectively in predicting

pneumonia in children. The PPV was 90.4% and the likelihood ratio was 12.10. The children with crepitations on examination are 12 times more likely to have pneumonia than children without crepitations. It was found to be significantly associated with pneumonia with a P value of <0.001. It was also one of the independent predictors of pneumonia with an Adjusted Odds Ratio of 123.95.

In our study, we found that presence of rhonchi had got a sensitivity and specificity of 36.36% and 25% respectively in predicting pneumonia in children. It was similar to the study done by Silayach et al[51], where they found that the presence of rhonchi has got a sensitivity and specificity of 32% and 25% respectively. In our study, we found that the presence of rhonchi was significantly associated with no pneumonia (P<0.001).

Mohammed et al[52] found that anemia was a risk factor for childhood pneumonia with a P value of 0.001 and odds ratio of 4.03. Hussain et al[47] found that anemic children were 4.6 times more susceptible to lower respiratory tract infections. These studies are similar to our study, in our study anemia had a sensitivity and specificity of 72.7% and 58.9% respectively in predicting pneumonia. It was found to be significantly associated with pneumonia with a P value of 0.002.

Mishra et al[93] in their study found that presence of malnutrition was significantly associated with pneumonia and other lower respiratory tract infections with a P value of 0.001. Similar was the observations by other researchers Yadav et al[94], Prasad et al[95], Savitha et al[96] and Broor et al[97]. These studies are similar to our study. In our study, presence of malnutrition as scored by wasting had a sensitivity and specificity of 63.64% and 85.71% respectively in predicting pneumonia. The

PPV and LR were 77.78% and 4.45 respectively. It was found to be significantly associated with pneumonia with a P value of <0.001. It was found to be one of the independent predictors of pneumonia with adjusted Odds ratio of 70.76.

History of vomiting, leukocytosis and positive CRP were not significantly associated with pneumonia in our study with P values of >0.05. History of wheeze and presence of rhonchi are associated with no pneumonia. However our study cannot be compared with many other studies as they all differ in study design, inclusion criteria, and age groups selected etc.

On testing the validity of the clinical variables, we observed that grunting (sensitivity of 70.4%, specificity of 94.6%, PPV of 91.1%), retractions (sensitivity of 84.09%, specificity of 85.71%, PPV of 82.2%) and crepitations (sensitivity of 86.36%, specificity of 92.86%, PPV of 90.48%) had got both high sensitivity and high specificity with more positive predictive value (PPV) in predicting pneumonia in children. With these findings we imply that complete respiratory system examination with auscultation is necessary to prevent the misdiagnosis and overenthusiastic use of chest radiograph and antibiotics in children.

After binominal logistic regression, we found that temperature $\geq 38^0$, crepitations and presence of malnutrition were independent predictors of pneumonia in all age groups in this study. Of them, temperature $\geq 38^0$ C is the strongest independent predictor of pneumonia with an Adjusted Odds ratio of 200.03.

This present cross-sectional study provides an insight into the factors that predict radiographic pneumonia among Indian children aged 2 months to 15 years. Chest radiography is an invasive investigation indicated for children suspected of

pneumonia. So, the risk of radiography must be balanced against the benefit in order to avoid unnecessary use of CXR for the diagnosis of pneumonia.

In our study, the major strength lies in its cross-sectional data collection and stratification of age groups among the study population. This helps in predicting chest X-ray positive pneumonia in different age groups with cough and fast breathing. We observed that 10% of children among study subjects had pneumonia in younger age group i.e. 2 months to 1 year. This is a significant finding as in this age group other illness like bronchiolitis are very common and the diagnosis of pneumonia can be easily missed without proper clinical examination and radiography. So, it should be properly addressed and radiography if required should be correlated clinically in order to avoid misdiagnosis. History of recurrent respiratory infections and nebulization from a reliable parent should be sought in younger children to rule out wheeze associated lower respiratory tract infection and to avoid unnecessary use of antibiotics and unnecessary chest radiographs.

In the present study, 15 clinical variables were selected which can predict radiographic pneumonia. Initially, 10 variables came out as significant which were analyzed individually to find out the significant predictors of radiographic pneumonia by bimanual logistic regression.

Other strengths include the study period of 12 months, which minimized seasonal variation. Consensus agreement of chest radiograph interpretation by two paediatricians involved in the study limited the error associated with inter-observer agreement. This was possible because of the good quality digital chest x-ray. This study focused on the use of predictive variables about which information is readily available to physicians when patients present. Majority of the children were from

rural background which represents true picture of prevalence of pneumonia in our society.

Many studies conducted so far among children with cough and/or fast breathing were done in children below 5 years of age. Patients with a prior history of wheezing or asthma were excluded from a number of studies. Hence the results cannot be generalized to the general population. Our study includes children up to 15 years of age and also those with previous history of wheeze/ asthma. This makes our study more generalizable.

The yield of chest radiograph in detecting pneumonia among children presenting with cough and fast breathing was 44% and presence of temperature $\geq 38^0$ C, crepitations and presence of malnutrition were found to be independent predictors of pneumonia.

SUMMARY

SUMMARY

- This is a hospital based descriptive study of pneumonia, with sample size of 100, done at Sree Mookambika Institute of Medical Sciences.
- Children aged between 2 months to 15 years presenting with cough and fast breathing were included in the study, those meeting the exclusion criteria are not included.
- Majority of children were in the age group 1 year to 5 years, who constitute 48% of the study population
- Males outweighed females with a male to female ratio of 1.77:1.
- Out of 100 subjects included in the study, 44% had radiographic pneumonia.
- Statistical analysis was done and sensitivity, specificity, PPV, LR, P value and Odds ratio of the clinical parameters were calculated.
- All the symptoms were found more in the age group 1 – 5 years, since more children are present in this age group in our study population.
- History of fever was found to be the most common symptom in the study population with 78%, followed by history of refusal of feeds/fluids in 48% of the study subjects.
- At the time of examination, temperature was $\geq 38^0$ C in 63% of children. 51% of children in the study population had oxygen saturation < 95%.
- Malnutrition, as scored by wasting was seen in 36% patients. No wasting was seen in 64 (64%) patients. It was found more in the age group 1-5 years (37.5%).

- All the respiratory parameters were present more in the age group 1-5 years, because of the increased number of study subjects in that age group.
- Positive CRP was present more in the age group 2 months to 1 year (44.4%). No positive CRP was found in the age group > 10 years.
- In our study, chest X-ray positive pneumonia was present more in the age group 1 – 5 years (22), followed by the age group 2 months to 1 year (10).
- In our study, the prevalence of chest X-ray positive pneumonia was more in the age group 6 – 10 years (52.94%).
- History of fever and refusal of feeds/fluids were significantly associated with pneumonia with P values of <0.023 and <0.001 respectively.
- Presence of history of wheeze was commonly associated with no pneumonia ($P < 0.001$).
- Both presence of temperature $\geq 38^0$ C and Oxygen saturation < 95% are significantly associated with pneumonia with P value of <0.001.
- The presence of malnutrition, scored by presence of wasting was significantly associated with pneumonia with P value of <0.001.
- All the respiratory parameters we studied are significantly associated with pneumonia with P value of <0.05.
- The presence of rhonchi was commonly associated with no pneumonia ($P<0.001$).
- Anemia was found in 72.7% of the pneumonia patients, it was found to be significantly associated with pneumonia with a P value of 0.002.
- The significant parameters in our study, presence of history of fever, refusal of feeds/fluids, presence of temperature $\geq 38^0$ C, oxygen saturation < 95%,

presence of nasal flaring, grunting, chest retractions, crepitations, presence of malnutrition (wasting) and presence of anemia had got sensitivity of 88.64%, 77.27%, 95.45%, 81.82%, 79.55%, 70.45%, 84.09%, 86.36%, 63.64% and 72.73% respectively in predicting pneumonia.

- The variables having both high sensitivity and specificity for predicting presence or absence of pneumonia were presence of history of refusal of feeds/fluids, oxygen saturation <95%, presence of grunting, chest retractions and crepitations.
- After binominal logistic regression analysis, we found that presence of temperature $\geq 38^0$ C, crepitations and presence of malnutrition were independent predictors of pneumonia in children. Of them, presence of temperature $\geq 38^0$ C is the strongest independent predictor of pneumonia with an Adjusted OR of 200.03.

LIMITATION

LIMITATIONS OF THE STUDY

1. The study was conducted in a tertiary care institute, hence the study population differs from the general population.
2. Less number of children were present in the age group of 6-15 years.
3. Children who presented with cough and fast breathing but for whom chest X-ray was not taken were excluded. This limits the generalizability of the results.
4. The outcome of the pneumonia cases were not studied.

CONCLUSION

CONCLUSION

This is a descriptive study done at Sree Mookambika Institute of Medical Sciences in children of age group 2 months to 15 years with sample size of 100, to find the association of clinical parameters like cough and fast breathing in radiologically confirmed cases of pneumonia.

Presence of cough and fast breathing is equated as clinical evidence of pneumonia among under-five children as per WHO guidelines. But clinicians often use these parameters above the age of 5 years as well. In this study, the association of the above clinical parameters with radiologically confirmed pneumonia was 37.03% in 2 months to 1 year, 45.83% in 1 – 5 years, 52.94% in 6 – 10 years and 37.5% in more than 10 years age. The other parameters that had significant association with radiologically confirmed pneumonia were presence of history of fever (P value= 0.023), refusal of feeds/fluids (P value=<0.001), temperature $\geq 38^0$ C (P value=<0.001), oxygen saturation < 95% (P value=<0.001), nasal flaring (P value=0.004), grunting (P value=<0.001), chest retractions (P value=<0.001), crepitations (P value=<0.001), anemia (P value=<0.001) and malnutrition (P value=<0.001). History of wheeze and presence of rhonchi were significantly associated with no pneumonia (P <0.001). This is of clinical interest as antibiotic abuse and unnecessary exposure to radiation to obtain chest X-ray to confirm pneumonia can be avoided in children with hyper reactive airway disease. Cough and fast breathing can be used as clinical parameters to identify pneumonia even in children more than 5 years of age, similar to less than 5 years old children.

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APPENDIX

APPENDIX – 1

SREE MOOKAMBIKA INSTITUTE OF MEDICAL SCIENCES

KULASEKHARAM

RESEARCH COMMITTEE

CERTIFICATE

This is to certify that The Research Protocol Submitted by Dr. K.V. MOHANASELVAN

Faculty / Post Graduate from Department of PAEDIATRICS

Titled ASSOCIATION OF CLINICAL PARAMETERS - COUGH AND FAST BREATHING WITH PNEUMONIA IN CHILDREN OF AGE GROUP 2 MONTHS TO 15 YEARS

is approved by the Research Committee.

Chair Person

Convenor
(Dr. R.S. KRISHNAMURTHY)

Prof & H.O.D.
Dept. of Physiology
Sree Mookambika Institute of Medical Sciences
Kulasekharam 629 161

Date : 17-11-2017

APPENDIX – 2

INSTITUTIONAL HUMAN ETHICS COMMITTEE

SREE MOOKAMBIKA INSTITUTE OF MEDICAL SCIENCES,
KULASEKHARAM, TAMILNADU

Communication of Decision of the Institutional Human Ethics Committee(IHEC)

SMIMS/IHEC No: 2 / Protocol no: 22/ 2017

Protocol title: ASSOCIATION OF CLINICAL PARAMETERS-COUGH AND FAST BREATHING WITH PNEUMONIA IN CHILDREN OF AGE GROUP 2 MONTHS TO 15 YEARS .
Principal Investigator: Dr.K.V.Mohanaselvan
Name& Address of Institution: Department of Paediatrics Sree Mookambika Institute of Medical Sciences ☑ New review ☐ Revised review ☐ Expedited review
Date of review (D/M/Y): 05-12-2017 Date of previous review , if revised application:
Decision of the IHEC: ☑ Recommended ☐ Recommended with suggestions ☐ Revision ☐ Rejected
Suggestions/ Reasons/ Remarks:
Recommended for a period of :One year

Please note*

- Inform IHEC immediately in case of any Adverse events and Serious adverse events.
- Inform IHEC in case of any change of study procedure, site and investigator
- This permission is only for period mentioned above. Annual report to be submitted to IHEC.
- Members of IHEC have right to monitor the trial with prior intimation.

Reneegajanjadhao

Signature of Member Secretary (IHEC)

SREE MOOKAMBIKA INSTITUTE OF MEDICAL SCIENCES
IHEC
Date...6/12/17...
KULASEKHARAM

APPENDIX – 3

CASE RECORD FORM

Serial no **:** **OP/IP NO:**

Date **:**

Name **:**

Age in years/months **:**

Address & Phone no **:**

Sex **:** **Male** **Female**

History of present illness

Fever :

Vomiting :

Wheeze :

Refusal of feeds/fluids :

Lethargy :

Cyanosis :

Stridor :

Past history **:**

Birth history :

Developmental history :

Nutritional history :

Immunization history :

Socioeconomic history **:**

GENERAL EXAMINATION:

Pallor :

Cyanosis :

Grunting :

VITAL SIGNS

Temperature (deg C) :

Pulse rate (per min) :

Respiratory rate (per min) :

Capillary Refill Time (sec) :

Oxygen saturation, SpO_2 (%):

ANTHROPOMETRY:

Weight (kg) :

Height (cm) :

Weight for age (%) :

Height for age (%) :

Weight for height (%) :

Wasting : Present/Absent

SYSTEMIC EXAMINATION:

Respiratory system

Nasal flaring:

Chest Retractions:

Rhonchi:

Crepitations:

Cardiovascular system:

Abdomen:

Central nervous system:

LABORATORY VALUES

Hb :

Tc :

Dc :

CRP :

CHEST X-RAY : Pneumonia /No pneumonia

APPENDIX – 4

MASTER CHART

S.No	Age	Sex	HoF	HoW	Vom	RoF	Temp >38 C	Spo2	Wasting	NF	Grunt	Retractions	Crepts	Rhonchi	Anaemia	Leucocytosis	CRP	CXR
1	10y	m	+	-	-	+	+	+	-	-	+	+	+	-	-	+	-	+
2	1y	f	-	+	-	+	-	-	-	+	-	-	-	+	-	-	-	-
3	8mt	m	+	-	-	+	+	+	-	+	+	+	+	+	-	+	+	+
4	9y2mt	f	+	+	-	-	-	+	-	-	-	-	+	-	-	+	+	-
5	11y	m	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
6	4y6mt	m	+	+	-	-	-	-	-	+	-	-	-	+	+	+	+	-
7	3y	f	+	-	+	+	+	+	+	+	+	+	+	+	+	+	-	+
8	7mt	f	+	-	+	+	+	+	-	+	+	+	+	-	+	+	+	+
9	3y8mt	m	+	+	-	-	-	-	-	+	-	-	-	+	-	-	-	-
10	2y	f	-	-	-	+	+	+	+	+	+	+	+	+	-	+	-	+
11	4y6mt	m	+	-	+	+	+	+	+	+	+	+	+	-	+	-	-	+
12	8mt	m	+	-	-	+	+	+	+	+	+	+	+	-	+	+	+	+
13	3y	f	+	+	+	-	+	-	-	+	-	-	-	+	+	+	-	-
14	6mt	f	+	-	-	-	+	+	-	+	-	-	-	+	+	-	-	-
15	14y6mt	m	+	+	-	-	-	+	-	-	-	-	-	+	-	+	-	-
16	2y	m	+	-	-	+	+	+	-	+	+	+	+	-	+	+	-	+
17	8y6mt	m	+	-	-	-	-	-	+	+	-	-	+	-	-	+	-	+
18	1y	f	-	+	-	+	+	-	-	+	-	-	-	+	-	+	+	-

19	2y	m	+	-	-	+	+	-	+	-	+	+	+	-	-	-	-	+
20	4mt	m	+	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-
21	8y6mt	f	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+
22	4y6mt	f	+	+	-	-	+	+	+	+	-	-	+	-	+	-	+	+
23	9mt	f	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
24	5y	m	+	+	-	-	-	+	-	-	+	-	-	+	+	+	+	-
25	10mt	m	-	+	-	+	-	+	-	-	-	-	-	+	+	-	-	-
26	9y6mt	m	+	+	+	+	-	+	-	-	-	-	+	-	-	+	-	-
27	1y	f	+	+	-	-	+	-	-	+	-	-	-	+	+	+	-	-
28	4mt	m	+	-	-	-	+	-	-	+	-	-	-	+	-	-	-	-
29	4y	m	+	-	-	+	+	-	+	+	+	+	+	-	+	-	-	+
30	5y	m	+	+	+	-	-	-	-	-	-	+	-	+	-	+	-	-
31	8mt	f	-	-	-	+	-	+	-	-	+	-	-	+	+	-	-	-
32	3y	f	+	-	-	+	+	+	-	+	+	+	+	-	-	+	-	+
33	11mt	m	+	-	-	+	+	+	+	+	+	+	+	-	+	-	-	+
34	13y6mt	f	-	+	-	+	-	+	+	+	+	+	+	-	+	+	-	+
35	1y	m	+	+	+	+	+	-	-	+	-	-	-	+	+	+	+	-
36	9mt	f	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-
37	9y	m	+	-	-	+	+	+	+	+	+	+	+	+	+	-	-	+
38	2y	f	+	+	-	-	+	+	-	+	-	-	-	+	-	-	-	-
39	4y	m	+	+	+	+	+	+	-	+	+	+	+	-	+	+	-	+
40	9mt	m	-	-	-	-	+	-	-	+	-	-	-	+	-	-	-	-
41	15y	m	+	+	+	-	+	-	-	-	-	-	+	-	-	+	-	-
42	3y	m	-	+	+	+	-	-	-	+	-	+	-	+	+	+	+	-
43	9mt	m	-	-	-	-	-	+	+	+	-	-	-	+	+	-	-	-
44	10y	m	+	-	-	-	+	-	-	-	-	-	-	+	-	-	-	+

45	2y	f	+	-	-	+	+	+	+	+	+	+	+	-	+	+	-	+
46	9mt	m	+	-	-	+	+	+	-	-	-	+	+	-	+	-	+	+
47	2y6mt	m	+	-	-	-	+	-	+	+	-	-	+	+	+	+	-	+
48	7y	m	+	-	-	-	-	-	-	-	-	-	+	+	-	+	-	-
49	4mt	m	+	-	-	+	+	+	-	+	+	+	+	-	+	+	+	+
50	10y	f	-	-	-	-	+	+	+	-	-	+	-	+	-	-	-	+
51	3y	f	-	+	+	-	+	-	-	+	-	-	-	-	+	+	-	-
52	3mt	m	+	-	-	+	-	-	-	+	-	-	-	+	-	+	+	-
53	2y	m	+	-	-	-	+	+	+	+	-	+	+	+	+	+	-	+
54	8mt	f	+	-	-	-	-	+	+	-	-	-	-	+	-	-	-	-
55	2y6mt	m	+	-	-	-	+	+	-	-	-	+	+	-	+	+	-	+
56	12y	f	+	+	-	-	-	+	+	-	-	-	-	+	-	-	-	-
57	6y	m	+	+	-	+	+	+	-	+	-	+	+	-	+	-	+	+
58	9y	f	-	-	-	+	+	-	+	-	-	-	-	-	+	-	-	+
59	11mt	m	+	-	-	+	+	+	-	+	+	+	+	-	+	+	+	+
60	4y6mt	m	-	+	+	-	+	-	-	+	-	-	-	+	+	+	-	-
61	6y	f	+	+	-	-	-	-	-	-	-	-	-	+	+	+	-	-
62	4y	m	+	-	-	+	+	+	+	+	+	+	+	-	-	-	-	+
63	9mt	m	+	-	-	+	+	+	-	+	+	+	-	+	-	+	-	-
64	2y	f	+	+	+	+	+	-	-	+	-	+	-	+	-	+	-	-
65	3y6mt	m	+	-	-	+	+	+	+	+	+	+	+	-	+	+	-	+
66	7mt	f	+	-	-	-	-	-	-	+	-	-	-	+	+	-	+	-
67	1y	m	-	+	+	-	-	-	-	-	-	+	-	-	+	-	-	-
68	9y	f	+	+	-	+	+	+	+	+	+	+	-	-	+	+	-	+
69	3y	m	+	-	-	-	+	+	-	+	-	-	+	+	+	-	-	+
70	10mt	m	-	-	-	-	-	+	-	-	-	-	-	+	-	+	-	-

71	2y	m	+	-	-	+	+	+	+	+	+	+	+	-	+	+	-	+
72	11y	f	-	-	-	-	+	+	-	+	-	+	-	+	-	-	-	+
73	1y	m	+	+	+	-	+	-	-	+	-	-	-	+	+	+	-	-
74	11mt	m	+	+	-	+	-	-	-	-	-	-	-	-	-	+	-	-
75	10y	m	+	+	+	-	-	+	-	+	-	-	-	-	-	+	-	-
76	1y3mt	m	+	-	-	+	+	+	+	+	+	+	+	-	+	+	-	+
77	11mt	f	-	-	-	-	+	-	+	+	-	+	-	+	+	-	-	-
78	2y6mt	f	+	+	+	-	-	-	-	+	-	-	-	+	-	-	+	-
79	5y	m	+	+	-	-	-	-	+	+	-	-	-	-	-	+	-	-
80	8mt	f	-	-	-	+	+	+	-	+	-	-	-	+	-	-	+	-
81	5y	m	+	+	+	-	+	-	-	-	-	-	-	+	-	-	-	-
82	8mt	m	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
83	15y	m	+	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-
84	1y2mt	m	+	+	-	-	+	-	-	-	-	-	-	+	-	-	-	-
85	10y	f	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
86	4y 6mt	m	+	+	-	-	-	-	-	+	-	+	-	+	+	-	-	-
87	2y 7mt	m	+	+	-	-	-	-	-	+	-	-	-	+	-	+	+	-
88	5y	m	+	+	-	-	-	-	+	+	-	-	-	+	+	+	-	-
89	9y	m	+	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-
90	2y 4mt	m	+	-	+	+	+	+	-	+	+	+	+	-	+	+	-	+
91	8mt	f	+	-	+	+	+	+	-	+	+	+	+	+	+	+	+	+
92	7y	f	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
93	11y	m	+	-	-	-	+	-	+	-	-	-	-	-	-	-	-	+
94	5y	f	+	+	+	+	+	-	-	-	-	-	-	+	+	+	-	-
95	10mt	m	-	-	-	-	+	-	+	+	-	+	-	+	-	+	-	-
96	2y	m	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+

97	2y	f	+	-	-	+	+	+	+	+	+	+	+	+	-	-	+	+
98	5y	m	-	+	+	-	-	-	-	-	-	-	-	-	+	-	-	-
99	1y 2mt	m	-	+	+	+	-	-	-	-	-	-	-	-	+	-	-	-
100	3y4mt	m	+	-	-	+	+	-	+	-	+	+	+	-	+	-	-	+

Key

HoF- history of fever
HoW- history of wheeze
Vom- vomiting
RoF- refusal of feeds
Temp $\geq 38^0$ C- temperature $\geq 38^0$ Celusis
SpO2- oxygen saturation
NF- nasal flaring
Grunt- grunting
Retractions- chest retractions
Crepts- crepitations
CRP- C-Reactive Protein
CXR- chest radiograph
+ → present
- → absent
Y – year
Mt – Months
M – Male
F – Female